

WHITE PAPER AP13

SECURE SOCIETIES

EXECUTIVE SUMMARY

The challenges related to Secure Societies encompass a large number of technological and scientific fields together with social science, with the final aim to design and implement solutions for safety and security by respecting the privacy of the citizens. Several main thematic areas can be identified according to the societal needs, which are requiring multi-disciplinary approaches and a continuously improved knowledge sharing and exchange among different worlds (practitioners, end-users, scientists, technologists, humanists).

In this context, DIITET is able to give an answer to the present and future technological and scientific challenges in national and international programmes (H2020, FP9, EDA,..), which have an impact on the improvement of the societal resilience.

In particular, the Institutes of DIITET are carrying on state-of-art activities in four areas.

The first one addresses the protection and the improvement of the critical infrastructures and of the Built Environment; in this field, DIITET is able to provide integrated solutions for the cyber-physical security and safety, as well as recommendations and strategies for the planning and designing of the built environment in view of the resilience improvement. Attention is also given to disaster risk management by the adoption of approaches combining modelling and inspection tools.

The second area is concerned with the fight against crime and terrorism, where DIITET has the capability to design and implement solutions for the effective crisis management in the cases of crowded areas and large events and methodologies/technologies for the detection and characterization of dangerous substances and objects. A new thematic is also under development regarding the use of social media as a support to crime prevention.

The third area is concerned with the border and maritime security, which is tackled under a holistic approach based mostly on the integration of novel surveillance technologies from different observation platforms (satellite, airborne, UAV, in-situ) and exploiting the advanced concepts of the robotics.

The last area is concerned with the ethical and social aspects of the security, where the contribution of DIITET addresses two specific necessities: 1) the safety of the workers against electromagnetic risk 2) the privacy issues associated to the surveillance systems.

Of course, this document is also and more important for renewing the knowledge sharing/integration in AP and between this AP and the other ones, in order to identify and give an answer to future scientific and social challenges in the field of safety and security.

1. STATE OF THE ART OF THE RELEVANT SCIENTIFIC AREA

Improvement of the Resilience for Critical infrastructures and Built Environment (including Cultural Heritage)

Cyber-physical security of critical infrastructures

Critical infrastructures are typically cyber-physical systems, often showing strong interconnections such that the disruption/collapse of one leads to a cascading/escalating effects on others (this is, typically, the case of electric power generation blackout). Analysis and assessment of resilience-related indicators of cyber-physical systems providing vital services, to detect vulnerabilities and support system design improvements, are among relevant research activities in this context (ISTI).

The study of innovative and last generation threats (malware, virus, dos tools, trojans, wireless attacks, covert channels, darknet threats) and the design and development of novel protection algorithms and solutions is

of increasing interest and covers contexts, such as critical networks, infrastructures and organizations and different scenarios and environments (IEIT).

Safety of critical infrastructures and built environment

In the field of protection of critical infrastructures, the theme of the analysis, prevention and mitigation of the risks associated with chemical processes and accidental combustion phenomena (explosions, fires, and release of toxic substances) is of paramount importance (IRC). Furthermore, it is essential to address detection and monitoring of leakages or unwanted release of CBRNE substances, by using remotely controlled sensors for gases, volatile substances, liquids, or spectroscopic X-ray detectors (IMEM). The above aspects are relevant to the sustainability of the process industry as well as to the effectiveness of both land use planning and civil protection action.

The design and implementation of systems able to couple long-term monitoring and quick damage assessment for critical infrastructures and built environment is another important research theme. The aim is the development of solutions integrating sensing technologies from different observation platforms (satellite, airborne, drones, in-situ) for the multi-scale monitoring and surveillance, not only of the structures but even of the embedding territory. The assimilation of the structural health monitoring results (based on non-destructive techniques) in modeling approaches for structural analysis plays a crucial role in supporting the decisions for long-term maintenance and management. (IREA, IFAC, ISTI, INM).

Improvement of the resilience for Built Environment and Urban Areas

Every year, high-impact weather events (HIWE) cause significant damages and casualties. Several research activities aim at supporting and facilitating the study of HIWE in a fully probabilistic multi-model and multi-data virtual research environments. Besides the pure probabilistic modelling of phenomena, other approaches are strongly connected to the three dimensional spatial extent of the entity under investigation and are based on surface or volume analysis and inspection. These approaches have applications in environmental monitoring, hazardous event prediction, structural maintenance, quality control to name a few. Digital Terrain models are ubiquitous in geospatial applications; 3D scalar and vector fields are used to model and simulate the state and evolution of environmental parameters, such as the evolution of the maxima of the rainfall field; computer vision is widely used for structural inspection. (IMATI)

The disaster risk is a crucial factor to be accounted for during the planning and design of built environment in order to improve resilience and assure the safety of the occupants. In this context, it is necessary to change paradigm and turns from the design, on the basis of only historical data, to the one based also on the forecast of future conditions. To pursue this aim, the research efforts are towards new approaches formulating methodologies and tools to evaluate the construction product and improving disaster resilience and risk prevention and management (ITC).

Fight against crime and terrorism

Physical threats detection

The development of systems able to detect and characterize dangerous substances and targets is now focusing on the design of: advanced X-ray scanners employed for baggage or goods controls in order to identify dangerous or illegal material, where the necessity is to improve their capability to discriminate target materials; systems for the detection of radioactive material in terroristic actions; radar systems for detection of dangerous concealed objects and landmines and IED (IREA, IMEM). Distributed sensing of dangerous and/or explosive substances is of primary importance and research efforts aim at improving sensitivity, size, cost and power-consumption, mainly to create large networks of stand-alone monitoring units (IMEM).

Crisis management for large events

Crowded areas and large events call for technologies aimed at monitoring, predicting and properly reacting to movements of people masses. It is of paramount importance to develop solutions able to collect and process heterogeneous data so to support risk analysis processes. These processes are based on approaches, which often need to be properly tuned to the target computing infrastructure. A recent trend is to run these algorithms on complex, heterogeneous and distributed platform composed of IoT devices, Clouds and

Cloudlets; many contributions have been proposed so far, including novel decentralized interaction paradigms, 5G-based communications as well as software defined infrastructures. (ISTI)
In this scenario, research efforts are also devoted to the design of effective techniques and technologies able to gather and process data from Social Media in near real-time by providing scalable data analytics approaches to support decision in crisis management (IIT).

Social media analysis as support to crime prevention

In the last years, there is an increasing research on the development of tools based on Social media as support to crime prevention by LEAs. In particular, the open issues concern with solutions enabling access to social media data, development of distributed and scalable algorithms (IIT).

Border and maritime security

Maritime/marine wide area surveillance

Synthetic Aperture Radar (SAR) from satellite platforms is one of the most deployed technologies for a wide area surveillance. In particular, a huge research effort has been devoted to target (ship) detection, classification and identification as well as the integration of SAR and optical data and the use of signals received from collaborative (unmanned) vessels as auxiliary information (ISTI, INM). Attention is also devoted to the development of fluorescence LIDAR systems as a useful tool for oil spills characterization (IFAC).

Security on ships and in port areas

It is important to design and implement:

- new on-board systems for security of passengers and crew, based on the integration of multi-sensorial surveillance and monitoring technologies (biometry, computer vision systems, radar,...) supervised by ICT architectures (IREA).
- Systems for security of ports based on the integration of sensing technologies from multi-observational platforms (airborne, drones, on-ground, underwater) for the control of the persons and goods (containers, vehicles,...) (IREA, IMEM, INM).

Robotics and UAV for maritime security

Robotic platforms, under-sea and surface, are important in the exploration of unknown environments, sampling and environmental characterization (bathymetry, measurement of geophysical or biological parameters, tracking in - pollutants, etc.), protection of coastal / port areas, support in intervention operations. The use of robotic units improves the quality of the collected data, in terms of resolution and repeatability of the measurement, as well as an optimization of the sampling times, thus leading to a global saving in terms of economic resources. A further reduction in costs is achieved through teams of autonomous small-medium sized vehicles characterized by reduced sensory and logistical equipment simplified. Recent studies have led to the development of intelligent robotic systems able to cooperate closely with humans (divers), in order to provide support in critical activities. Maritime surveillance activities also require in-flight observations, which can be supported by autonomous systems (drones), to allow fast surveillance. These systems can be coupled with autonomous marine platforms, thus extending the observational coverage (INM).

Ethical Societal Dimension and Social Security

EMF safety in work environment

The promulgation of the 2013/35/EU Directive generated a considerable demand, by public and private control bodies, for know-how about the assessment of occupational exposure to electromagnetic field. The publication of the "Non-binding Guide to Good Practices for the Implementation of the Directive" (Nov 2014) did not meet all the needs. At the time of the transposition of the Directive in the Italian law (Aug 2016), resources (specialists, standardized assessment procedures and instrument chains) able to face these issues were not completely available; even the awareness on occupational EMF risks was lacking in many public and private bodies (IFAC).

Furthermore, the issue of occupational exposure to electromagnetic fields has to be addressed by developing tools and strategies for exposure assessment of workers in health (with particular attention to Magnetic Resonance Imaging, MRI, environments) and maritime sectors, and for the evaluation of possible health effects (IREA).

Privacy issues in Security systems

The awareness about the respect of the privacy of the people represents one of the main constraint in designing technological solutions. Attention is devoted to the development of privacy aware physical surveillance systems, where the research is focussed on approaches to ease the video control of physical resources (including access to sensitive location) still being able to minimize the data collected/stored and processed (IIT, INM).

2. CONTRIBUTION TO THE RELEVANT SCIENTIFIC AREA

Improvement of the Resilience for Critical infrastructures and Built Environment (including Cultural Heritage)

Cyber-physical security of critical infrastructures

ISTI carries out analysis and assessment of critical infrastructures through the development of a stochastic model-based framework to analyze the effect of interdependencies in smart grids and to provide quantitative assessment of resilience-related indicators in presence of malfunctions. Quantifying the impact of failures (due to either accidental faults or cyber-attacks) on the capability to provide correct service is a key factor for designing countermeasures to mitigate vulnerabilities revealed in critical assets.

Network Security group of the IEIIT is a pioneer in the design of innovative cyber-attacks, and has brought contribution to the research, by introducing the term “slow dos attack”, relatively to last generation denial of service attacks, also by proving for the first time that such threats can be successfully executed on not performant hosts. Simultaneously, protection methodologies, applied to different last generation cyber-threats, were proposed. IEIIT has implemented advanced algorithms to protect against new generation attacks and solutions aimed at optimizing the performance of a telecommunications network. The focus is not only in critical infrastructures in general (see ANASTACIA project), but also on specific infrastructures (see FINSEC project).

Safety of critical infrastructures and built environment

IRC carries out activities along three main research lines, by adopting approaches based on the development of experimental prototypes and protocols as well as predictive mathematical models, and theoretical and numerical methodologies.

- 1) Process safety - Loss of control of chemical systems: runaway phenomena; instabilities of chemical processes; industrial toxicology (products of thermal decomposition, and organic and inorganic particulate matter produced by combustion systems);
- 2) Combustion safety - Explosion phenomena of gas/vapor, dust and hybrid (dust-gas/vapor) systems; propagation and extinguishment of industrial fires; response of materials to fires; propagation of wildland fires on a landscape;
- 3) Risk assessment - Methodologies for Na-Tech, domino effect and security; land use planning for industrial sites and forest management; methodologies for the analysis of industrial and natural hazards.

IREA has significant expertise in designing and implementing sensing and monitoring solutions based on the integration of sensing technologies. The relevant technologies are: Synthetic Aperture Radar for the monitoring of the displacement (deformations) of the soil and structures by exploiting Sentinel and COSMO-

SKYMED data; optic fiber sensor for a distributed monitoring of temperature and strain over long distance (till kilometres) and resolution of the order of meter; ground penetrating radar systems on several platforms (helicopter, UAV, on-ground) for inspection of the underground and inner parts of the structures.

ISTI has consolidated competences about the development of mechanical models and software for the structural analysis and health monitoring of ancient masonry constructions. In particular, the NOSA-ITACA FE code (available at www.nosaitaca.it) allows for modelling the nonlinear behaviour of masonry constructions under static and dynamic loads, by taking into account the material's inability to withstand tensile stresses.

IFAC gives its contribution with:

- 1) Design and construction of fluorescence LIDAR systems (spectral and temporal domain, fluorescence hyperspectral imaging, fluorescence lifetime imaging) operating from different platforms (ground-based, airborne, helicopter, shipborne).
- 2) Design and implementation of ad-hoc algorithms for lidar data processing in specific contexts (cultural heritage, railway infrastructure, etc.).
- 3) Thermographic analysis with state-of-the art instrumentation and physical-mathematical modelling of thermal processes.

Improvement of the resilience for built Environment and Urban Areas

IMATI is involved in research activities to support and facilitate the study of HIWE in a fully probabilistic multi-model and multi-data virtual research environments, through the seamless integration of heterogeneous hydro-meteorological modelling and data services and focusing on the event scale (days to weeks, *DRIHM and DRIHM2US EU projects*). IMATI works also in the modeling of big geospatial data (e.g., indexing and structuring of LiDAR point clouds for fast access to relevant data, *in the context of the iQmulus EU project*) and has expertise in the morphological characterization, e.g., for the identification of drainage basin and the terrain change detection in successive campaigns. IMATI adopts change detection techniques on rain fields to track storms and predict hazards. IMATI is also developing methods for the analysis of 3D scalar fields for driving the adaptive sampling of environmental parameters, e.g. for real-time water pollution monitoring (*MATRAC Interreg project*). IMATI has expertise in point clouds registration and in surface analysis and characterization for the damage detection of wagons and for the quality evaluation of naval hulls, by using 3D computational geometry approach and not vision methods.

ITC carries out research for code developing and technical assessment of innovative materials and products for construction, through:

- 1) Approaches able to evaluate the resilience and the impact on the societal security of the new construction products subjected to earthquake, flood, freezing weather, hail, high winds, hurricane, lightning, tornado and wildfire;
- 2) Teaching the techniques for assessing risk levels and resilience of the installed construction product in courses and training schools for engineers, architects, experts, consultants and manufacturers;
- 3) Giving technical support to the Community institutions and the Member States towards issuing binding technical standards;
- 4) Providing society with a sense of security of the new buildings despite the unstable environmental conditions.

Fight against crime and terrorism

Physical threats detection

IMEM is now developing:

- 1) on-demand production of room-temperature spectroscopic X-ray and gamma-ray detectors and detection systems to be used in spectroscopic x-ray scanners or compact devices for detection and identification of radioactive sources (also integrated in aerial/terrestrial drones);

- 2) high sensitivity sensors for gas and volatile substances detection, based on nanostructured oxide materials, on functionalized semiconducting nanowires and carbon nanotubes;
- 3) sensors for detection of chemical substances in liquids.

IREA has expertise in the development of advanced data processing (microwave imaging) for Through wall imaging, concealed objects detection and landmine/IED detection/localization, also thanks to the adoption of new observation configurations (forward looking, imaging beyond an obstacle) requiring the analysis by means of advanced electromagnetic modelling.

Crisis management for large events

ISTI contributes to crisis management in crowded areas and large events with smart and decentralized solutions targeting infrastructures for enabling the distributed data monitoring and collection as well as the timely filtering and analysis of the collected data. ISTI also develops advanced data analytics solutions able to extract useful and contextualized knowledge from data, such as people presence, trajectories characterizing people masses, optimized escape routes. The derived knowledge can be presented and visualized to event organizers or security officers.

IIT is working on the capability to exploit Social Media data with the aim to design and implements situational awareness tools for crisis management in large events. The proposed techniques exploit big data technologies and advanced artificial intelligence algorithms so to extract information supporting crisis management.

Social media analysis as support to crime prevention

Social Media analysis is today a critical brick in supporting LEA's work in crime prevention. IIT is making research efforts to develop tools for: Social Media Analysis for crime prevention (hate speech detection, analysis of users' interactions, face similarity recognition, etc.); Social Sensing for Social Good; Health metrics for social ecosystems.

Border and maritime security

Maritime/marine wide area surveillance

ISTI is involved in maritime surveillance solutions by developing:

- i) marine safety/security surveillance and monitoring services;
- ii) pervasive smart camera networks for environmental monitoring and video surveillance;
- iii) computer vision methods making Unmanned Aerial Vehicles (UAVs) suitable for applications as monitoring of strategic targets and infrastructures, data acquisition in search and rescue operations and multimodal survey and mapping of large areas.

IFAC gives its contribution with:

- Design and construction of fluorescence LIDAR systems operating from different platforms (airborne, helicopter, shipborne, UAV);
- Design and implementation of ad-hoc algorithms for lidar data processing in characterization of oil spills, colored dissolved organic matter, algal blooms, etc..

Security on ships and in port areas

IREA is able to develop technological solutions based on radar systems for the remote monitoring of the movement and behavior of the persons (vital signs, indications of suspected behavior) and degree of occupancy of indoor environments. IREA has also expertise in the development of data processing for Terahertz systems for imaging and spectroscopy analysis of dangerous substances.

IRC can contribute with the safety risk assessment for ships and port areas, where flammable substances are stored, handled, and transported.

Robotics and UAV for maritime security

INM has expertise in the field of cooperative autonomous robotic systems for both waterborne and airborne segments, able to gather multispectral data in a reduced time-frame, by providing remote sensing to human operators. Measure-based and adaptive decision schemes provide advanced autonomous capabilities allowing the robotic framework to evolve and comply with a time-changing operating environment.

Ethical Societal Dimension and Social Security

EMF safety in work environment

IFAC can contribute in the field of the assessment of occupational exposure to EMF through: A) management of measurement surveys in workplaces and in the environment; B) teaching in training events for employers, consultants and safety personnel; C) design and development of standardized methods, *ad hoc* instrument chains and adequate measurement and data processing procedures, both for radiometric and dosimetric approaches.

The contributions of IREA to the issue of occupational exposure to EMFs include:

- Measurement campaigns in living and working environments;
- Development of numerical tools for the computation of exposure levels in MRI environments;
- Characterization of EMFs sources and exposure scenarios for workers of the maritime sector;
- Evaluation of genotoxic effects in biological samples of buccal mucosa from exposed workers;
- Education, training and information activities for workers and security managers through the development of websites, videos and the use of augmented reality communication techniques.

Privacy issues in Security systems

IIT, with the support of INM for maritime environment, is able to produce systems that allow a careful control of the situation using surveillance systems. In addition, these systems also can protect the privacy of the involved people, by limiting at minimum the personal identifiable information. The systems work both with biometric aspects as well as for mobility patterns and allows a win-win solutions for security and privacy.

3. IMPACT

Scientific impact

- *Number of papers (only on International Journals in the period 2013-to present: **about 360***
- *Organization and participation to scientific committees of main events (conferences, workshops): **About 60.** (The detailed list is reported as an ANNEX and we are not counting the number of editions for the same conference)*
- *Editorial Board membership of Journals*

Editor in Chief

Open Access Journal HERITAGE (<http://www.mdpi.com/journal/heritage>)

Members of EBM

IEEE Transactions of Geoscience and Remote Sensing, IEEE Transactions on Computational Imaging, Remote Sensing (MDPI); Heritage (MDPI); IEEE Transactions on Image Processing; Science Publishing Group Communications, 2018; STRUCTURAL MAGAZINE; Computers journal (MDPI); Bioelectromagnetics; Plos One; Scientific Reports; Frontiers in Public Health – Radiation and Health; Scientific World Journal – Biophysics; The Open Biomedical Engineering Journal.

Guest Editors of Special Issues: 23

- *Awards*

- L.N. Anishchenko, S.I. Ivashov, F. Soldovieri, I. Catapano, L. Crocco, "COMPARISON STUDY OF TWO APPROACHES FOR DATA PROCESSING BIORADAR", awarded Best Poster at IET International Radar Conference 2013, Xi'an, China, April 2013.
- Serit (Security Research in ITaly) Award 2012 to the laboratory "Radar for security applications and land monitoring IREA", whose coordinators are Gianfranco Fornaro and Francesco Soldovieri.
- Andrea Zappettini: Room Temperature Semiconductor Detector Scientist Award 2017, for lifetime achievement - Atlanta, USA, October 24th 2017 (by Room Temperature Semiconductor Detector Steering Committee)
- "Dynamic High-Rise Moment Resisting Frame Dissipation Performances Adopting Glazed Curtain Walls with Superelastic Shape Memory Alloy Joints" World Academy of Science, Engineering and Technology International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering Vol:11, No:4, 2017 (A. Bonati, L. Casagrande, F. Auricchio, A. Occhiuzzi) – BEST PAPER AWARD at 19th ICTBBS 2017
- Judges Award for the paper "ABCD SW: Autistic Behavior & Computer-based Didactic Software." In: Proceeding W4A '12 Proceedings of the International Cross-Disciplinary Conference on Web Accessibility.
- Best Paper Award for the paper "Automatic Aerial Image Alignment for GeoMemories" at MMEDIA 2013, The Fifth International Conferences on Advances in Multimedia, Venice, Italy
- SAGE Ocean Concept Grant 2018 for the project "Digital DNA Toolbox". Sage Publishing.
- "Occupational exposure to electromagnetic fields in MRI: a tool for risk assessment". 2016 Best Italian Electromagnetic Compatibility Poster Prize, at the 2016 IEEE Electromagnetic Compatibility day
- S. Biasotti, A. Cerri, S. Pittaluga, D. Sobrero, and M. Spagnuolo. (2016) Tracking the evolution of rainfall precipitation fields using persistent maxima. STAG: Smart Tools and Apps in computer Graphics (2016). Genova, Italy. October 3-4, 2016. DOI: 10.2312/stag.20161361
- G. Patane', A. Cerri, V. Skytt, S. Pittaluga, S. Biasotti, D. Sobrero, T. Dokken, and M. Spagnuolo. (2015) A comparison of methods for the approximation and analysis of rainfall fields in environmental applications. ISPRS Geospatial Week 2015. La Grande Motte, France. 28 Sep - 03 Oct 2015. DOI: 10.5194/isprsannals-II-3-W5-523-2015

- *Participation to European Research Infrastructures*

ISTI is a member of European Research Infrastructures SoBigData

ITC is member of EOTA, a non-profit organization that coordinates the application of the procedures set out for a request for a European Technical Assessment (ETA) and for the procedure adopting a European Assessment Document (EAD). EOTA also informs the European Commission (EC) and the Standing Committee on Construction of any question related to the preparation of EADs and suggests improvements to the EC based on its experience gained.

IREA is involved in E-RiHS.

Industrial impact

- *Main collaborations with companies*

IFAC has helped to address non-trivial issues of assessment of exposure to electromagnetic fields in many large Italian companies, such as: Enel, Terna, Trenitalia, Italcertifer, Eni.

IFAC has worked in collaboration with a small enterprise to the feasibility study of an ultra-compact fluorescence LIDAR to be deployed from an Unmanned Air Vehicle (UAV).

IFAC is working in a regional funded project (TOSCA-FI: Optoelectronic tool for mortar-cement-steel structures – Italia railways), in collaboration with SMEs (Tesifer srl, Durazzani srl) and with the support of Trenitalia, for the development of an integrated system for the diagnostics of railway bridges.

CNR (IMATI) leads the Competence Centre START4.0 "Security and optimization of strategic infrastructures 4.0 " funded by MISE in Industry 4.0 call. The project involves also the Liguria Region, the Port System Authorities, Unioncamere and the Confindustria Digital Innovation Hub, with the collaboration of RINA and the participation of Ansaldo Energia, Ansaldo STS, ABB, Cetena, IREN, Leonardo, Softeco and several SMEs.

ISTI collaborates with Mapsat, Telerilevamento Euromediterraneo Srl and Sister Sistemi Territoriali Srl for maritime surveillance in the framework of ESA GSTP project OSIRIS, Optical/SAR data and system Integration for Rush Identification of Ship models.

IMEM cooperates with XNEXT, an Italian SME advanced inspection technology company and CAEN SYS, a SME working on innovative nuclear measurement solutions to enhance Nuclear Safety.

IRC closely collaborates with several companies to address industrial safety issues (Fike Europe BVBA, Mitsubishi Heavy Industries, Avio Aero, DSM S.p.A., Novartis S.p.A., etc.).

ITC supported many national and international manufacturers during the CE process of their construction products.

IREA has an assessed cooperation with several companies as Leonardo, Fincantieri, E-Geos, IDS, NAIS, Consorzio TERN, Digimat, Geocart (not exhaustive list).

- *Involvement in National and International technological platforms*

SERIT (Security Research in ITaly). SERIT is the Technology Platform on National Security jointly promoted by CNR and Finmeccanica, which groups companies and institutions in Italy dealing with research in the field of Homeland Security. Currently, the platform includes more than 250 Italian partners with over 1000 members. *Fabio Martinelli (IIT) is Co-Chair of SERIT.*

- *Patents*

- Patent 0001378208, (30 July 2010), Title: Method of processing data collected using Synthetic Aperture Radar (SAR) and its remote sensing system.
- European Patent (European Patent), EP2017647A1, (Jan 21, 2009). Title: Method for processing data sensed by a synthetic aperture radar (SAR) and related remote sensing system
- Patent 0001395231, (publication 2009, Grant 2012), Title: System GPR Stepped Frequency reconfigurable.
- Patent 0001428337 (publication 7/08/2016, Grant 24/04/2017), Title: Georadar System.
- Patent RM2013A000239 (2013), Title: Apparatus for flammability and explosion tests of uniformly dispersed dusts.

- *Spin-off*

- SPIN-OFF CNR Remocean SPA (www.remocean.com). The spin-off was founded in 2010 as a partnership between IREA and INSEAN.

- SPIN-OFF CNR Cleis Security s.r.l. (www.cleissecurity.it). The spin-off was founded in 2006. <https://www.cnr.it/it/spinoff/21/cleis-security-s-r-l>

Social Impact

- *Activities in cooperation with public institutions to address social challenges*
 - IFAC has been collaborating with major national public bodies in charge of physical surveillance of EMF (ISPESL, INAIL, ISS, ENEA, SNPA) with the aim to develop standardized assessment methods.
 - The constitution of a joint research center between Polizia di Stato and IIT-CNR (named CRAIM) is currently allowing technology transfer from Social Media research activities to LEA in order to support crime prevention.
 - IRC is working in cooperation with ISA (Istituto Superiore Antincendi - Corpo Nazionale dei Vigili del Fuoco), Parco Nazionale del Vesuvio, Regione Campania, and the Greek Ministry of Rural Development and Food (Department of Forest Resources Development) to address the issues of mitigation, prevention and reduction of the risk of forest fire accidents.
 - ITC is performing studies and results carried out to support the legislative framework development.
 - IREA is Center of Competence of the Civil Protection Department (DPC) for SAR data processing aimed at the detection and evaluation of earth surface deformation. IREA has an assessed cooperation with MIBACT and Archaeological Park of Pompei.
 - IREA In the last years, thanks to the collaboration with INAIL-Regione Campania, the issue of occupational exposure to EMFs has been addressed, by developing tools and strategies for exposure assessment of workers in the health (with particular attention to Magnetic Resonance Imaging, MRI, environments) and maritime sectors.
 - IMATI is collaborating with REGIONE LIGURIA and ARPAL by providing processing services for the LiDAR data set of Liguria. IMATI has developed new services to provide Regione Liguria for environmental monitoring and protection.
 - ISTI is collaborating with many public and private bodies in charge of the maintenance and surveillance of monuments in Tuscany (with particular regard to the territories of Livorno and Lucca). Since 2015 the Laboratory is involved, in collaboration with the Italian Institute of Geophysics and Volcanology (INGV), in the long-term vibration monitoring of medieval towers and bridges. ISTI collaborated with the Florence engineers' association and the Lucca architects' association for the organization of training courses.
 - INM cooperates with the Italian Navy Hydrographic Institute for deep water Polar environment sampling and formation of young graduate students towards the employment of robotic tools for in-water sampling.

Political impact

- *Participation to High-level working groups at national and international level*
 - Maurizio Aiello is National Representative for Italy at the European Commission, as part of the "Secure Societies - Protecting Freedom and security of Europe and Its Citizens" configuration of the European Research program Horizon 2020.
 - Antonio Bonati is member of: "ACCREDIA" Governing Council (2018/2020), "Certification and testing for the construction industry" (ICMQ) Governing Council, "Italian Organization for Standardization (UNI) Working Group" for "Fire Reaction" and "Fire Safety Engineering (Fire Behavior/ Active fire protection system), Sector Group SH2 of GNB/CPR (Group of Notified Bodies for the scientific and technical cooperation and exchange of information in accordance to European Regulation UE 305/2011); PT4 Fire Council of the European Organization for Technical Assessment (EOTA), "EGOLF"

(European Group of Organisation for Fire Testing, Inspection and Certification), (from 2005 to 2011) for the implementation and verify the European Standard Framework of fire Reaction and Resistance of the Construction Products. Antonio Bonati is in charge of development of the Guidelines for the design and qualification construction products and systems, by the High Council of Public Works of Ministry of Infrastructure and Transport. Antonio Bonati is member of the work group of the Italian Ministry of Labour and Social Policy for the technical document development “Scaffolding – Instructions for the construct and use”.

- Felicita Di Giandomenico is a member of the Connect Advisory Forum for ICT Research and Innovation, European Commission.
- Valeria Di Sarli is Governmental Expert of the CapTech “Ammunition Technologies” in European Defence Agency (EDA) (since 2018), member of the “European Research Community On Flow, Turbulence And Combustion” (ERCOFTAC) (since 2008), and elected member of the directive board of the “Interdivisional Group for Safety in Chemical Environment” (GISAC) of the “Italian Chemical Society” (SCI) (2018-2020).
- Fabio Martinelli is member of the Protection and Security Advisory Group (PASAG) of the EC and First Director of the European Cyber Security Organization.
- Francesco Soldovieri is Governmental Expert of the CapTech “Radio Frequency Sensors Technologies” in European Defence Agency (EDA), member of the Scientific Board of CNIT, Member of the Working Group on the Preparation of the Work Programme 2018-2020 “Secure Societies” (topic Disaster Resilience) for European Commission.
- Maria Rosaria Scarfi is Council member at the Italian Electrotechnical Committee (CEI) (2013-present) and Council member of the European Bioelectromagnetics Association (since 2017). Maria Rosaria Scarfi is a member of the Core group for the preparation of the World Health Organization monograph on risk assessment for RF fields (2012 – present) and of the Scientific Committee of the Swedish Radiation Safety Authority – Electromagnetic Fields (2013-present).
- Olga Zeni and Maria Rosaria Scarfi have been experts of the Working Group on Electromagnetic Fields for the “Opinion on the potential health effects of exposure to electromagnetic fields”, European Commission, Scientific Committee on Emerging and Newly Identified Health Risks (*SCENIHR*) (2015).
- Olga Zeni is a member of the the IEEE international committee on Electromagnetic Safety Literature Review (2015 – present).
- ITC is the Italian Technical Assessment Body and develops European Assessment Documents (EADs) used as technical standard in order to affix the EC mark on new and innovative construction products. Moreover, ITC is in charge of the technical assessment of construction products and is entitled to issue European Technical Assessments (ETAs). ITC participates to the Scientific Panel of the CEN/WS Smart-CE-Marking “Smart CE marking for the construction industry”
- ISTI is involved in ITU (United Nations specialized agency for ICT) by participating to the Study Group 13 “Future networks, with focus on IMT-2020, cloud computing and trusted network infrastructures”.

4. EMERGING RESEARCH CHALLENGES

Besides, the “obvious” challenge of the integration of technologies and solutions, which entails a significant effort to activate a bridge between different disciplines, in the following we recall very briefly the specific research challenges.

Modeling of complex systems

Stochastic analysis of critical systems with evolving components (such as distributed energy resources in smart grids); model-based evaluation of large, interconnected systems; trade-offs optimization among contrasting system properties (e.g., safety, availability, security); risk assessment and mitigation.

Cyber-threats and cyber-attacks for critical infrastructures

Integration of Internet of Things devices on critical infrastructures (industrial IoT); Security aspects of Internet of Things devices and networks.

ICT

Big Data Processing Analytics and Social Mining; Management and orchestration of a decentralized computing infrastructure; solutions for achieving distributed indexing and collection of information in emergency scenarios; approaches for the timely and reliable processing of (big) data.

Social media and privacy issues

Privacy aware data analytics, including specific protocols to minimize sensitive and private information for security protocols. This entails both authentication protocols as well as biometric protocols.

Sensing/surveillance technologies: Integration and fusion of multi-scale, multi-depth multi-sensor data; Automatic classification/identification capabilities, with the integration of heterogeneous data; assimilation of the results of monitoring systems in structural analysis methods; new miniaturized sensors; exploitation of new observation platforms.

Safety of critical infrastructures, built environment (including cultural heritage)

Long-term, continuous structural health monitoring and real-time damage detection techniques; development of algorithms for improving efficiency and reliability of numerical codes for structural analysis of the built environment; Safety assessment format for quick aftermath building inspections; Seismic design of selected non-structural building components; innovative materials and products for constructions; New experimental standards/prototypes and new software tools for the design of prevention and mitigation measures for process and combustion safety; development of software tools for the analysis of cascading effects.

Disaster Resilience: safeguarding and securing society

Moving from the event scale to the seasonal scale in the modeling of potentially hazardous events; seamless integration of heterogeneous software tools and data services; new adaptive strategies to environmental sampling in different conditions and deploy fleet of cooperating robotic units; Portable and efficient 3D acquisition for on-field inspection; Augmented Reality vision systems to support human operators in the maintenance of complex structures.

EMF safety in work environment for maritime

EMF exposure conditions of maritime workers by accounting for the features of on-board technologies, sources positions, boats dimensions and materials affecting the EMF propagation.

5. CONCLUSIONS

DIITET institutes can give a significant contribution in many fields of the Secure Societies thematic, as testified by the significant research and technological transfer activities in many areas related to both security and safety. This is testified also by the large number of emerging research challenges envisaged by the contributors to this document, varying from ICT and “software”, hardware solutions as well as modeling tools to critical Infrastructures and Build Environment and maritime safety and security.

A very brief SWOT analysis is summarized in the following.

Strengths: Good scientific impact in terms of scientific production and involvement in the scientific organizations (journals, conferences..); good cooperation with industries and technological transfer activity; good capability to respond to society challenges by the cooperation with public institutions and stakeholders;

significant positioning in high-level national and international working groups; significant availability of facilities instrumentations, ICT and modeling tools in several fields; significant involvement in national and international projects (about 4MEuro of funding) also with coordination of H2020 projects; good international visibility.

Weaknesses: Despite of the good results obtained by every Institute, the cooperation, collaboration and integrated approach should be encouraged in order to achieve a critical mass and to respond to the scientific and technological challenges.

Opportunities: Institutes of AP are able to catch the funding opportunities offered by the different calls, also thanks to the involvement in the high-level working group and the assessed cooperation with different entities (national and international, industries, research institutes, end-users). The transversality is the main characteristic of AP 13 group and this can enable the collaboration with other APs and CNR Departments.

Threats: No specific threats are identified, scientific research overlap could be occurred but it could be converted in opportunity of a collaboration among the AP groups, with the aim to tackle emerging challenges and respond to societal needs.

PROJECT AREA 13: SECURE SOCIETIES

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