Progetti PRIN 2022 “Scorrimento” D.D. 1401 del 18.09.2024

Politecnico di Torino

27 nuovi progetti PRIN 2022 per il Politecnico di Torino

Il MUR con Avviso D.D. 1401 del 18.09.2024 ha disposto lo scorrimento delle graduatorie del Bando PRIN 2022 (D.D. n. 104 del 02-02-2024). Il nostro ateneo è risultato vincitore di 27 progetti nel Bando PRIN 2022 – scorrimento, i cui dettagli si riportano nel seguito del documento.

MicrowaveRad - Absolute microwave radiometers for primary thermometry, astrophysics and fundamental physics

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Simone Corbellini

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Codice identificativo progetto:

2022SJSZJL

Ruolo PoliTo:

Partner

Abstract

Nell'ambito della termodinamica della teoria di Yang-Mills SU(2), una fase preconfinante nella propagazione elettromagnetica a frequenza microonde e bassa temperatura è stata proposta come possibile spiegazione per le anomalie osservate nella radiazione di background cosmico. Questo progetto di ricerca mira ad testare sperimentalmente questa congettura fondamentale sviluppando un radiometro criogenico assoluto allestito in un laboratorio sulla Terra. L'esperimento sarà progettato per misurare la radiazione totale emessa da un corpo nero a temperature comprese tra 8 K e 28 K nell'intervallo di frequenza che va da 4 GHz a 20 GHz. L'esperimento realizzerà una tecnica di termometria radiometrica primaria idonea per determinare la temperatura termodinamica, che è di interesse per la diffusione diretta del kelvin nella sua recente ridefinizione nel Sistema Internazionale di Unità (SI). Questa nuova definizione si basa sull'attribuzione di un valore esatto fisso al costante di Boltzmann. L'esperimento deve risultare sufficientemente preciso e accurato, richiedendo abilità avanzate in radiometria, misure a bassa temperatura e microonde. Questi requisiti sono soddisfatti dal consorzio che riunisce le competenze e le strutture disponibili presso l'Istituto Nazionale di Metrologia (INRIM) e il Dipartimento di Elettronica e Telecomunicazioni (DET) del Politecnico di Torino

Strutture coinvolte

- DET - Dipartimento di Elettronica e Telecomunicazioni

Partner

- **INRIM** - Coordinatore
- **INRIM**
- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE**

Parole chiave

Settori ERC

PE2_2 - Particle physics PE2_15 - Non-linear physics PE2_17 - Metrology and measurement

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 9. Costruire un'infrastruttura resiliente e promuovere l'innovazione ed una industrializzazione equa, responsabile e sostenibile

Budget

Costo totale progetto:	€ 321.050,00
Contributo totale progetto:	€ 187.740,00
Costo totale PoliTo:	€ 96.650,00
Contributo PoliTo:	€ 72.650,00

MicroBioNIC - Microscale Biosensing eNabled by Integrated Circuits with digital sensor interfaces and micromachined ultrasound transducers (MicroBioNIC)

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Paolo Stefano Crovetti

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Codice identificativo progetto:

2022RJKLW2

Ruolo PoliTo:

Coordinatore

Abstract

Swarms of drinkable biosensing devices with dimensions comparable to a blood cell, suitable to be internalized in the human body so that to sense, acquire and transmit outside the body information of clinical interest have been recently envisioned as the new frontier of biomedical electronics. Such microscale biosensors would have ground-breaking applications, among the others, in cancer tracking, diagnosis and cure of brain disorders, non-invasive, real-time monitoring of metabolites, biomarkers, drugs and pathogens, as required to identify the source and to track the evolution of diseases, to enhance the effectiveness of therapies and to significantly improve the quality of life of patients. Turning this vision into reality demands tens-of-micrometers-scale, sub-microwatt power, remotely powered and controlled biosensing chips that are well beyond the state of the art of wearable and implantable devices, and whose design and fabrication raise unique multidisciplinary challenges. In the MicroBioNIC project we are going to tackle and overcome the IC design challenges of microscale biosensing by new, ground-breaking concepts in sensor acquisition and in wireless power and data transfer, which we are going to develop and demonstrate on silicon, as needed to meet the requirements of a microscale biosensing platform integrated on chip

Strutture coinvolte

- DET - Dipartimento di Elettronica e Telecomunicazioni

Partner

- **POLITECNICO DI MILANO**
- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE** - Coordinatore
- **UNIVERSITA' DEGLI STUDI DI CATANIA**

Parole chiave

Settori ERC

PE7_5 - (Micro and nano) electronic, optoelectronic and photonic components PE7_4 - (Micro and nano) systems engineering PE7_11 - Components and systems for applications (in e.g. medicine, biology, environment)

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 3. Assicurare la salute e il benessere per tutti e per tutte le età

Budget

Costo totale progetto:	€ 217.585,00
Contributo totale progetto:	€ 173.191,00
Costo totale PoliTo:	€ 104.255,00
Contributo PoliTo:	€ 85.925,0

EXTRA-NET - Extracting essential information and dynamics from complex networks

Durata:

08/02/2025 - 08/02/2027

Responsabile scientifico:

- Giacomo Como

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Codice identificativo progetto:

2022MBC2EZ

Ruolo PoliTo:

Partner

Abstract

Dynamic network models are an essential tool for the analysis and control of biological, physical and social phenomena. As the number of nodes and edges grows their analysis and simulation becomes prohibitive. Yet, in most applications the aim is to answer structural or high-level questions whose answers exhibit little or no dependence on the "microscopic" description of the network, making its complexity largely irrelevant. This is true for continuous-state network models as well as finite state models, including those used for epidemic systems, gossip interactions in opinion dynamics, learning and evolutionary games. Most applications share common features: 1. Even for medium size networks and low dimensional state spaces of the nodes, both simulation and inference become intractable. 2. Neither the network nor the state are known exactly and there may be restrictions on the admissible configurations. 3. The interest is often on the structural organization of the network (e.g., the presence of hierarchical structures, the degree of controllability of the network, and/or the "small world" property) or on the behavior of certain macro-observables (e.g., the number of infected individuals and the extent of the contact between infected or not infected in an epidemic model, the polarization of opinions in a social network model, or rather the spread of a mutant species in a biological system). 4. Interventions and control actions can only be done at a macro level prescribing laws for all nodes in a region (e.g., when performing neurostimulation only a whole region of the brain can be targeted), or for all nodes with certain characteristics (e.g., rules in epidemiological emergencies, taxes in economic systems). Items 1. and 2. indicate that microscopic models are way too large to be profitably analyzed in detail and/or inferred from data, but 3. and 4. also suggest that typically not all that complexity is really needed and only a macroscopic description may be sufficient. The main goal of the project is

to develop methods to construct reduced aggregated models that can be used for decision and control purposes, exploiting symmetries while capturing relevant structural information. Understanding how this aggregation can be performed for network systems and which is the optimal grain for the given high-level task is a formidable problem that calls for novel tools, especially if a fully automated algorithm is sought that is also robust to noise and limited information. Our approach relies on the definition of a new continuous (and hence tractable) measure balancing the complexity of the network with the prior information about structural organization of the network and/or with the macro-observable under scrutiny. The potentially groundbreaking research goals of this proposal are mainly motivated by two formidable applications that will also represent a testbed for our project, namely network models for the brain dynamics and epidemic spread.

Strutture coinvolte

- DISMA - Dipartimento di Scienze Matematiche "G. L. Lagrange"

Partner

- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE**
- **UNIVERSITA' DEGLI STUDI DI PADOVA** - Coordinatore

Parole chiave

Settori ERC

PE7_1 - Control engineering

Budget

Costo totale progetto:	€ 272.869,00
Contributo totale progetto:	€ 173.248,00
Costo totale PoliTo:	€ 67.519,00
Contributo PoliTo:	€ 43.313,00

DECORI - anomaly DEtection exploiting COmpression for systems health monitoRIng

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Gianluca Setti

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Codice identificativo progetto:

2022AKBFKJ

Ruolo PoliTo:

Coordinatore

Abstract

A typical scenario for nowadays massive acquisition systems can be modelled as a large number of sensing units, each transforming some physical unknown quantity into samples of random processes that are then transmitted to a central unit collecting them. To reduce transmission bitrate, signals are often compressed by a lossy mechanism that, if properly tuned, is capable of preserving useful information. Having such large amount of data makes also possible the design of a suitable mechanism for the identification of piece of signal deviating from what is usually observed, i.e., the design of data-driven tools and methods in the framework of anomaly detections. Such a scenario can be declined in many important application areas. Among these, project DECORI focus on structural health monitoring of civil infrastructures and on satellites diagnostic. For the processing of the signal necessary for anomaly detection, we consider two different setting where i) the signal is also processed on-board of (or close to) the sensors acquiring it, or ii) it is first dispatched and then processed on a remote node. In case i) computational resources are a fundamental constraint, but the simultaneous availability of both the original and compressed signal make it possible to detect anomalous cases by assessing situations were the compression algorithm performs poorly. Conversely, case ii) is not affected by any significant constraint in terms of computational budget or memory footprint, but processing can be performed only on the compressed data so that the effectiveness of any possible method for anomaly detection is strictly connected to the amount of information extractable from the received data, i.e., it depends on the capability of the on-board compression stage to correctly preserve all useful information. DECORI aims to advance in several directions. The first step forward will be theoretical, addressing the problem on how compression affects distinguishability which has only been minimally investigated in the literature. Answering to

this question will allow to optimize compression not only with respect to data rate but also with respect to anomaly detection. Such theoretical framework will be exploited in the design of optimized anomaly detectors based on machine learning/artificial intelligence for both scenarios of local and remote processing. Finally, these methods will be applied to two important use cases, namely structural health monitoring for civil infrastructures and on-board diagnostic of satellites. For both scenarios measured data will be used and made available, as well as the code developed in DECORI to ensure, according to the FAIR principle, complete reusability of the results of the project.

Persone coinvolte

- **Gianluca Setti** (Responsabile Scientifico)
- **Gabriele Bertagnoli** (Responsabile Scientifico di Struttura)

Strutture coinvolte

- DET - Dipartimento di Elettronica e Telecomunicazioni
- DISEG - Dipartimento di Ingegneria Strutturale, Edile e Geotecnica
- SmartDat - SmartData@PoliTO - Big Data and Data Science Laboratory

Partner

- **ALMA MATER STUDIORUM UNIVERSITA' DI BOLOGNA**
- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE** - Coordinatore

Parole chiave

Settori ERC

PE7_7 - Signal processing PE6_11 - Machine learning, statistical data processing and applications using signal processing (e.g. speech, image, video) PE7_11 - Components and systems for applications (in e.g. medicine, biology, environment)

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 9. Costruire un'infrastruttura resiliente e promuovere l'innovazione ed una industrializzazione equa, responsabile e sostenibile

Budget

Costo totale progetto:	€ 230.432,00
Contributo totale progetto:	€ 155.823,00
Costo totale PoliTo:	€ 116.086,00

Contributo PoliTo:	€ 78.500,00

MuSe: Multi-Sensor wearable device for telemedicine

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Leonardo Iannucci

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Codice identificativo progetto:

2022WT443M

Ruolo PoliTo:

Coordinatore

Abstract

Telemedicine represents a unique opportunity and a pervasive challenge to support active aging. Considering the constant increase in the average age, the percentage of adults over 65 in Italy is expected to rise from the current 23% of the total to about 35% in 2050, with a considerable impact on the national healthcare systems, due to significant increase in the need for professional services, social care and healthcare provision. In this scenario, it is essential to exploit the possibility to monitor elderly patients from home, without the need to frequently perform costly medical analyses in hospitals. Among the opportunities offered by new technologies and interdisciplinary research, wearable devices represent a unique tool for telemedicine thanks to their intrinsic ability to combine accurate feedback on a person's health status with ease of use and comfort [1]. Even though several wearable devices have been already proposed during the last decade, still few of them have been specifically designed for addressing the elderly as end-users. Thus, to gain acceptance of wearables as a reliable tool for telemedicine, a step ahead is required in terms of device robustness, accuracy, integration with microfluidics for sample processing, ease of use, and comfort [2]. In this picture, the present proposal addresses the design and the realization of a stand-alone wearable device to monitor hydration and health status of the elderly by exploiting a multi-sensing approach. In particular, electrodes for Bio-Impedance Analysis (BIA), sensors for skin hydration monitoring, and electrochemical sensors for ions and metabolites will be combined. Thus, they can all be miniaturized and easily integrated into a single wearable device (e.g., bracelet, patch). Portability, ease of use, accuracy of measurement, robustness, and flexibility will be primarily addressed in the design of the device. An approach based on printed electrodes interfaced with a multi-channel portable front-end will be exploited. In detail, impedance spectroscopy will be employed to quantify

skin hydration, body composition, and validate sweat sample volume, while potentiometry and chronoamperometry will be employed to quantify ions and metabolites, respectively. Laboratory characterization of each of the sensors will be performed to assess their metrological characteristics. After that, the design of the portable front-end will be addressed, integrating electronics for signal processing and wireless data transmission. In vivo tests will be then performed, exploiting both exercise-induced and natural sweat sampling. All obtained results will be compared with those collected using certified instrumentation. The final aim will be to implement a prototype of a stand-alone lowpower device able to upload in real-time the logged data on a dedicated remote cloud platform and to provide warning alarms of critical situations when defined thresholds for the target analytes are overcome.

Strutture coinvolte

- DISAT - Dipartimento Scienza Applicata e Tecnologia

Partner

- **POLITECNICO DI MILANO**
- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE** - Coordinatore
- **UNIVERSITA' DEGLI STUDI DI PADOVA**

Parole chiave

Settori ERC

PE7_11 - Components and systems for applications (in e.g. medicine, biology, environment) PE4_8 - Electrochemistry, electrodialysis, microfluidics, sensors

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 3. Assicurare la salute e il benessere per tutti e per tutte le età

Budget

Costo totale progetto:	€ 196.420,00
Contributo totale progetto:	€ 173.810,00
Costo totale PoliTo:	€ 69.616,00
Contributo PoliTo:	€ 61.006,00

NeTS - DC smart grids for next generation transportation systems

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Pietro Colella

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Codice identificativo progetto:

2022K3EHZ5

Ruolo PoliTo:

Coordinatore

Abstract

Transport contributes by almost 25% to the total GHG emissions in Europe and is the main cause of air pollution in cities. Hence, clear actions towards the decarbonisation of the urban road transport would be largely beneficial since more than 70% of the European citizens live in urban areas. Increasing the use of public transportation is for sure one of the main strategies. Unfortunately, the current status of the public transport infrastructure requires enhancements in order to attract a greater number of users. The integration of reliable models of Urban Traction Electrification Systems (UTESs) and Public Transport Vehicles (PTVs) would allow the improvement of the service by identifying more beneficial configuration of the network, detecting criticalities both in UTESs and PTVs, and taking remedial actions to fix the problems before they occurred according to the predictive maintenance approach. To do so, the quantities that should be monitored in quasi real-time are the positions of the vehicles, their electrical demands, the current flows and voltages in all the network branches and nodes, and the contribution of each substation. The currently adopted UTES models do not grant satisfactory and reliable results. Therefore, to overcome their limitations and foster the energy and digital transition, it is necessary to move towards a more sophisticated approach: The Digital Twin (DT). According to industry 4.0, DT is defined as a real physical imitation on digital model for the purpose of system optimization, monitoring, determining and predicting of future problem by employing Artificial Intelligence (AI), machine learning and software analysis including big data from physical systems. The main objectives of the project are: 1. to identify the barriers to the implementation of Urban Traction Electrification Systems (UTES) Digital Twins (DTs), as well as the strategies to overcome them; 2. to design, develop and test, in the lab and on-site, a prototype of a multifunction low-cost smart meter to monitor the pantograph

voltage and current demand, as well as the geographical position of a PTV in UTES characterized by a rated voltage up to 1.5 kV; 3. to design, develop and test an open source, multi-layer, client-server DT model of a UTES; 4. to use the UTES DT model within two research areas, which are the integration of DC-connected generators and loads into UTESs, and the implementation of Predictive Maintenance (PM) algorithms. External support will be provided by two companies for all the activities of the project: Infra.To and GTT, which own and manage the Urban Traction Electrification Systems (UTESs) and the Public Transport Vehicles (PTVs) in Turin, respectively.

Strutture coinvolte

- DENERG - Dipartimento Energia

Partner

- **I.N.RI.M. - ISTITUTO NAZIONALE DI RICERCA METROLOGICA**
- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE** - Coordinatore
- **UNIVERSITA' STUDI TRENTO**

Parole chiave

Settori ERC

PE7_12 - Electrical energy production, distribution, application PE7_3 - Simulation engineering and modelling PE7_8 - Networks (communication networks, sensor networks, networks of robots, etc.)

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 9. Costruire un'infrastruttura resiliente e promuovere l'innovazione ed una industrializzazione equa, responsabile e sostenibile | Obiettivo 11. Rendere le città e gli insediamenti umani inclusivi, sicuri, duraturi e sostenibili | Obiettivo 13. Promuovere azioni, a tutti i livelli, per combattere il cambiamento climatico*

Budget

Costo totale progetto:	€ 225.795,00
Contributo totale progetto:	€ 174.901,00
Costo totale PoliTo:	€ 86.850,00
Contributo PoliTo:	€ 69.960,00

WPT-SAFE - Electromagnetic modeling and design of WPT systems in compliance with EMC and safety guidelines for automotive applications

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Luca Giaccone

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Codice identificativo progetto:

20224XN8RF

Ruolo PoliTo:

Partner

Abstract

Electric vehicles (EVs) are deputed to replace conventional internal combustion engines (ICEs) in the next future. However, their widespread diffusion is still limited by the charging infrastructure and their on-board energy storage systems, mainly batteries. This results in a limited coverage range for EVs compared to ICEs. To overcome the so-called 'range anxiety', static (S) or dynamic wireless transfer power (D-WPT) systems have been proposed to transfer electric power to an EV when it is moving along an electrified road. Whereas this technology is extremely promising, it presents several issues including electromagnetic compatibility (EMC) problems with other electrical infra-structures and electromagnetic field (EMF) safety for human exposure of passengers or bystander in the walkside. Indeed, WPT coil currents are an intentional source of EMFs and hence any reduction in the magnetic field can negatively affect the performance of the WPT system itself. Extreme attention must be therefore paid to the combined design of the WPT coils and shields. This topic is new, very hot and challenging. Currently the shields are applied only after the realization of the WPT systems, without taking into account the problems of mitigation of the magnetic field in the design phase of the WPT coils. This entails a significant increase in costs and times to comply with the standards and regulations of EMC and EMF safety. The ultimate goal of the Research Project is then to develop guidelines for complying with EMF exposure limits and to design an efficient shielding technique to mitigate the magnetic field produced by D-WPT coils. Despite these tasks are very ambitious, the Research Units (RUs) have the skills and necessary

experience to carry out the objectives of the Project, as evidenced by several publications on issues related to the Project. Indeed, the PI has gained a huge experience in the field of numerical dosimetry and EMF safety compliance. He is member of the IEEE-International Committee on Electromagnetic Safety (ICES)-Technical Committee (TC) 95-Subcommittee (SC) 6 and of the International Electrotechnical Commission (IEC) TC 106, specifically of the Working Group (WG) 9, which is an ad-hoc WG related to the human exposure of WPT systems. The substitute of the PI instead has large experience in electronic power converters (switching) and advanced control systems. The responsible of the PoliTO RU has a consolidated experience in modelling and designing magnetic field mitigation systems. Furthermore, he is strongly active in the field of numerical dosimetry and member of IEC TC 106 and IEEE-ICES-TC95-SC6 as well. Moreover, he is currently serving the ICNIRP as member of the Scientific Expert Group (SEG). Finally, the responsible of the UniRM1 RU has long experience in the field of EMC, shielding theory and techniques, and WPT technology.

Strutture coinvolte

- DENERG - Dipartimento Energia

Partner

- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE**
- **Università degli Studi dell'Aquila** - Coordinatore
- **UNIVERSITA' DEGLI STUDI DI UDINE**
- **UNIVERSITA' DI ROMA "LA SAPIENZA"**

Parole chiave

Settori ERC

PE7_3 - Simulation engineering and modelling PE7_2 - Electrical engineering: power components and/or systems PE7_11 - Components and systems for applications (in e.g. medicine, biology, environment)

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 9. Costruire un'infrastruttura resiliente e promuovere l'innovazione ed una industrializzazione equa, responsabile e sostenibile

Budget

Costo totale progetto:	€ 245.746,00
Contributo totale progetto:	€ 174.863,00
Costo totale PoliTo:	€ 43.583,00

Contributo PoliTo:	€ 33.200,00

GREEN-ENERGY - HydroGen pRoduction from nuclEar ENergy for European Net zEro emissions stRateGY

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Sandra Dulla

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Codice identificativo progetto:

2022RL5TKX

Ruolo PoliTo:

Partner

Abstract

The sustainability of the energy production is a key issue that is nowadays under the spotlight. The ambitious objective of the European Union to be climate-neutral by 2050 requires the decarbonization of the transportation sector and the industrial processes. The role of hydrogen as energy carrier has been identified as crucial in various carbon neutral pathways. The potentiality for decarbonation offered by hydrogen requires that its production is powered by low-carbon sources, and nuclear energy, along with renewable sources, offers the opportunity to achieve this goal. In this context, the GREEN-ENERGY (HydroGen pRoduction from nuclEar ENergy for European Net zEro emissions stRateGY) project aims at studying the feasibility of hydrogen production from nuclear energy, assessing the design and safety aspects of the coupling of a nuclear reactor with a hydrogen production plant. The project focuses on the solid oxide electrolyzer cell (SOEC) as a pathway to H2 generation, coupled to a nuclear reactor suitable to reach the requested temperature ranges. A proper selection of the reference nuclear system will be made considering both current light water reactor technology (which allows shorter industrial deployment) and Generation-IV concepts. The design of the electrolyzer plant will be carried out, defining and optimizing the entire process flow. A dynamic model of the nuclear-hydrogen system will be developed to simulate the capability of the plant to shift from the electricity production to the hydrogen production when required from the electrical grid needs. The latter information will be provided through the development of long-term scenarios on electricity demand and production up to 2050. According to the safety culture characterizing the nuclear sector, a safety assessment of the nuclear-hydrogen

system will be performed to identify possible critical points associated with the coupled behavior. Given the innovative features of the plant, a methodology for embedding safety provisions in the design phase will be applied, along with the identification of safety-relevant events and associated risks. A deterministic safety transient analysis will complement the investigation to prove that the safety functions of the nuclear power plant are not compromised in case of malfunctions coming from the hydrogen plant. The outcomes of this project will open a pathway for the effective utilization of the nuclear source in the so-called hydrogen economy. This will allow the creation of new jobs and business opportunities for the Italian hydrogen industry, and the acceleration of the technological development both in SOEC and nuclear engineering fields. In addition, the project will help in addressing the potentialities in such non-electric application of Generation-IV nuclear reactors, as the lead-cooled fast reactor, currently under study at the European level and with a strong involvement of Italian companies and research entities.

Strutture coinvolte

- DENERG - Dipartimento Energia

Partner

- **POLITECNICO DI MILANO** - Coordinatore
- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE**
- **UNIVERSITA' DEGLI STUDI DI PALERMO**
- **UNIVERSITA' DI ROMA "LA SAPIENZA"**

Parole chiave

Settori ERC

PE8_6 - Energy processes engineering PE7_12 - Electrical energy production, distribution, application

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 7. Assicurare a tutti l'accesso a sistemi di energia economici, affidabili, sostenibili e moderni

Budget

Costo totale progetto:	€ 243.171,00
Contributo totale progetto:	€ 184.984,00
Costo totale PoliTo:	€ 48.619,00
Contributo PoliTo:	€ 34.281,00

RaRiskD - Rapid landslide risk mitigation: design for sustainability criteria in mountain areas (RaRiskD)

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Sofia Fellini

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (MINISTERO UNIVERSITA' E RICERCA)

Codice identificativo progetto:

2022XLK7ZN

Ruolo PoliTo:

Partner

Abstract

The IPCC report [1] recognizes the interdependence of climate, ecosystems and human societies. Landslides triggered by climate change are a clue of this interaction: they cause enormous damages, aggravated by the degradation of infrastructures and the abandonment of inland areas. Italy is one of the countries most affected by landslides [2], and about a third of these are rapid phenomena, such as rockfall (RF) and debris flow (DF) [3]. Near real-time geophysical monitoring of landslide properties is particularly needed for analyzing the complex process of precursory pre-failure mechanisms and constraint the time and spatial evolution of unstable volumes. Structural adaptation responses are fundamental for reducing the associated risk. Moreover, the current economic context and the new policies related to the environment, which have set very ambitious targets of carbon neutrality by 2050, confront us with new challenges, including the design approach for protecting and safeguarding inland from landslides. The concept of "oversizing of countermeasures", which also brings an undesired additional carbon footprint associated with extra materials and works, should be rethought in the framework of sustainability while keeping the highest safety standards intact. This research aims to propose and develop innovative approaches, integrated with Life Cycle Assessment (LCA), with priority on carbon footprinting (CF), for the design of countermeasures against RF and DF in inland areas, paying particular attention to their economic and environmental sustainability.

Strutture coinvolte

- DIATI - Dipartimento di Ingegneria dell'Ambiente, del Territorio e delle Infrastrutture

Parole chiave

Settori ERC

PE8_3 - Civil engineering, architecture, maritime/hydraulic engineering, geotechnics, waste treatment PE8_11 - Sustainable design (for recycling, for environment, eco-design)

Budget

Costo totale progetto:	€ 263.146,00
Contributo totale progetto:	€ 184.870,00
Costo totale PoliTo:	€ 124.633,00
Contributo PoliTo:	€ 92.357,00

BIO-RESTORE - BIO-based Resilient Energy and Seismic retrofiT Of the REsidential building stock

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Marco Domaneschi

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (MUR)

Codice identificativo progetto:

202234HM8J

Ruolo PoliTo:

Partner

Abstract

Italy is a territory characterized by a high seismic risk both in terms of intensity and frequency, as well as for damages caused to building heritage. Statistical studies showed that in the last 120 years, on average, a destructive event occurred each 5 years. Although Italy is, to date, classified as a country with less seismicity than territories such as California and Japan, characterized by frequent and violent earthquakes, the relationship between the damage produced and the energy released during the events is much more burdensome for our peninsula. Only in the last twenty years, significant seismic events occurred in Italy. From this scenario it is clear the need to deepen more and more the seismic behaviour of buildings to design innovative technical solutions to achieve an ever-greater standard of seismic safety, which adapts to any structural typology. The interventions on the building heritage are different depending on whether they are carried out on new structures or on existing buildings. The project summarizes two distinct issues in a single solution: (i) energy saving, by optimizing the building thermal insulation; (ii) seismic behaviour, introducing a system capable of providing a contribution in terms of strength and, limitedly, dissipation to the building structure. The proposed solution can be defined as an innovative dry seismic coat in the form of a classic panels adopting green materials, having into a unique element a thermal insulation system combined with a seismic-resistant device. The expected results will be classified in relation to: (i) improvement of energy performance, compared to a classic coat insulation system able to achieve a sufficient level of resiliency to climate change, adopting materials with low environmental impact; (ii) Increased seismic safety, through the insertion of a system capable of reducing and delaying the

damage to the elements of the load-bearing structure of the building. Furthermore, the proposal relies on the development of a design abacus, i.e. a practical guide and a detailed and personalized vademecum of seismic coat solutions to be adopted according to both the building construction technology and the design parameters dictated by the climatic and seismic zones where the construction is placed. Overall, the simplicity of application of the seismic coat and its wide applicability to any built context will allow to transform the building heritage into seismically safe and energetically self-sufficient structures, allowing at the same time to operate architectural restyling and functional requalification of urban fabrics. For demonstration purposes, the proposed panels will be applied to a portion of an existing reinforced concrete building designed in the absence of anti-seismic regulations.

Strutture coinvolte

- DISEG - Dipartimento di Ingegneria Strutturale, Edile e Geotecnica

Partner

- **C.N.R. - CONSIGLIO NAZIONALE DELLE RICERCHE** - Coordinatore
- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE**

Parole chiave

Settori ERC

PE8_3 - Civil engineering, architecture, maritime/hydraulic engineering, geotechnics, waste treatment PE8_9 - Production technology, process engineering

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 11. Rendere le città e gli insediamenti umani inclusivi, sicuri, duraturi e sostenibili

Budget

Costo totale progetto:	€ 184.887,00
Contributo totale progetto:	€ 128.113,00
Costo totale PoliTo:	€ 55.479,00
Contributo PoliTo:	€ 40.799,00

SMASHit - Sustainable Maintenance of Asphalt Surfaces with Hybrid solutions for secondary ITalian road networks

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Lucia Tsantilis

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (MINISTERO UNIVERSITA' E RICERCA)

Codice identificativo progetto:

2022LFBYKY

Ruolo PoliTo:

Coordinatore

Abstract

The SMASHit project focuses on an innovative experimental-methodological approach that will be used for the design of sustainable maintenance strategies for the Italian secondary road network. The project activities will be carried out following these main research steps: - Evaluation of the current maintenance practices in terms of strategies, materials and operations; - Technology development at a laboratory scale of new materials based on hybrid solutions; - Maintenance solution design based on performance and environmental criteria; - Overall project demonstration and validation by means of real-scale applications in trial sections. The research aims at the increase in knowledge in maintenance activities, thus allowing the exploitation of new technologies in hybrid solutions as well as promoting the reuse of specific waste for hot asphalt mixtures. Waste recycling increases the life cycle of products, bringing economic benefits to the overall processes while improving the wellbeing of the ecosystem. This approach is also in line with the 9th Sustainable Development Goal that helps to promote new technologies and resilient infrastructure with an efficient use of resources.

Strutture coinvolte

- DIATI - Dipartimento di Ingegneria dell'Ambiente, del Territorio e delle Infrastrutture

Parole chiave

Settori ERC

PE8_3 - Civil engineering, architecture, maritime/hydraulic engineering, geotechnics, waste treatment PE8_11 - Sustainable design (for recycling, for environment, eco-design)

Budget

Costo totale progetto:	€ 240.761,00
Contributo totale progetto:	€ 179.941,00
Costo totale PoliTo:	€ 115.713,00
Contributo PoliTo:	€ 83.686,00

A quantitative framework for structural robustness assessment

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Valerio De Biagi

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (MUR)

Codice identificativo progetto:

2022ATK8LK

Ruolo PoliTo:

Coordinatore

Abstract

Structural robustness is a key point in the design of resilient structures. Focusing on civil engineering, design codes require new structures to be sufficiently robust, but there are no particular requirements for quantifying such robustness. The literature review indicates that, although there are several approaches for quantifying the robustness of a structure, there is not a preferred metrics. Meanwhile, a threshold value for determining whether or not a structure is robust is missing. Essentially, this is the result of the fact that there are no tools for classifying the structural robustness, e.g., comparing different structures with respect to their robustness. Furthermore, structural robustness approaches are focused on civil structures rather than general structures like mechanical, marine, naval, or biomedical, in which, for example, there are no fixed supports and the system is in equilibrium with external loads only, or gravity loads are not the dominant actions on the structural system. The goal of the proposed research project is to create, test, and apply trustworthy tools for evaluating the robustness of structures. To outdo the current approaches, the project will be concerned with generic structures, both civil and non-civil.

Persone coinvolte

- Valerio De Biagi (Responsabile Scientifico)
- Foad Kiakojouri (Componente gruppo di Ricerca)

Strutture coinvolte

- DISEG - Dipartimento di Ingegneria Strutturale, Edile e Geotecnica

Partner

- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE** - Coordinatore
- **UTIU - Università Telematica Internazionale UNINETTUNO**

Parole chiave

Settori ERC

PE8_3 - Civil engineering, architecture, maritime/hydraulic engineering, geotechnics, waste treatment PE8_4 - Computational engineering

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 11. Rendere le città e gli insediamenti umani inclusivi, sicuri, duraturi e sostenibili

Budget

Costo totale progetto:	€ 178.358,00
Contributo totale progetto:	€ 144.487,00
Costo totale PoliTo:	€ 98.650,00
Contributo PoliTo:	€ 81.852,00

REHARZE - REtrofitting Historic Architecture foR Zero Emissions (REHARZE)

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Alessia Monaco

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Codice identificativo progetto:

Prot. 2022HRCNSL

Ruolo PoliTo:

Partner

Abstract

With the construction industry being responsible for almost half of the global emissions, the sustainable reuse of the existing buildings is considered the most relevant step to be taken toward low carbon targets. The Italian built environment comprises a vast number of ageing historic structures, whose repair still involves a considerable usage of raw materials and energy-intensive processes. In this view, deploying sustainable and innovative procedures for structural rehabilitation is an objective of relevant national interest. REHARZE will focus on the structural use of natural reinforcing fibres in combination with inorganic matrices to create a 'fully-green' composite retrofitting system – known as Natural Textile Reinforced Mortar (NTRM) - particularly suitable for masonry structures. To date, experimental and analytical studies focusing on NTRM are limited, causing further industry investments into non-renewable fibrous materials and matrices. The goals of REHARZE are a) to mechanically characterise renewable plant-based NTRM composites and validate their suitability as strengthening systems for masonry buildings; b) to optimise the material architecture as a function of the components, and c) to set design rules for promoting their deployment in the market. Experimental and numerical-theoretical studies entail the participation of three Research Units (RUs): University of Salerno (UniSa), Polytechnic of Torino (UniTo) and Polytechnic of Bari (PoliBa). The experimental activity will be performed by PoliTo and UniSa RUs. PoliTo will lead the mechanical characterisation of NTRM composites. Tensile tests will be performed on both single threads and dry fabric samples as well as on NRTM composites coupons. UniSa will lead the experimental analysis of the bond behaviour by performing direct single-lap shear tests on NTRM strengthened masonry prisms. The experimental tests will be aimed at exploring the influences of several geometrical and mechanical properties such as fibre type, strip

width, number of layers number and thickness of the matrix. The system performance will be assessed by analysing the constitutive behaviour, the peak load, the failure modes, the reinforcement efficiency rate, and the shear stress-slip interface constitutive law. The numerical-theoretical activity will be informed by the results of the experimental tests and analysis, that will serve to validate and calibrate numerical models. PoliBa will lead the overarching goal to provide a key contribution to the industrial deployment of efficient natural fibre-based reinforcing grids. The synergic collaboration among the RUs will lead to the development of a) a detailed computational approach for the identification of key factors of the NTRM behaviour, b) a Genetic Algorithm informed routine for the topological optimisation of the composite as a function of the components, c) sound analytical formulae for the design prediction of the NTRM performance.

Persone coinvolte

- Alessia Monaco (Responsabile Scientifico)
- Fabrizio Barpi (Responsabile Scientifico di Struttura)
- Pietro Cornetti (Responsabile Scientifico di Struttura)

Strutture coinvolte

- DAD - Dipartimento di Architettura e Design
- DISEG - Dipartimento di Ingegneria Strutturale, Edile e Geotecnica

Partner

- **POLITECNICO DI BARI**
- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE**
- **UNIVERSITA' DEGLI STUDI DI SALERNO** - Coordinatore

Parole chiave

Settori ERC

PE8_3 - Civil engineering, architecture, maritime/hydraulic engineering, geotechnics, waste treatment

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 9. Costruire un'infrastruttura resiliente e promuovere l'innovazione ed una industrializzazione equa, responsabile e sostenibile

Budget

Costo totale progetto:	€ 243.944,00
Contributo totale progetto:	€ 184.999,00

Costo totale PoliTo:	€ 90.167,00
Contributo PoliTo:	€ 61.666,00

DiTHiCe - DIGITAL TWIN DEVELOPMENT FOR THE RESILIENT MANAGEMENT OF MINOR HISTORICAL CENTRES

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Valentina Villa

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (MUR)

Codice identificativo progetto:

20228YYRWR

Ruolo PoliTo:

Partner

Abstract

Developing resilient cities is a strategic goal, made even more evident by recent events, not only in terms of dealing with chronic stresses such as social, economic and financial ones, but especially with emergency situations. Human settlements can be considered complex systems based on relationships between physical elements, such as density, morphology, accessibility, infrastructure and non-physical elements, such as relationships, citizenship rights, digital networks. When a disaster occurs, the degree of complexity is amplified exponentially and traditional urban management systems, based on classic paradigms, may be completely ineffective. This is particularly true for minor historical centres, which are often on the edge of decision-making centres, inherently non-resilient and hostile to any large-scale recommissioning program. Therefore, new management approaches are required to implement safety, resilience and sustainability. In this context, the challenge that research must face is to develop a system that allows to be supported in the management of minor centres by eliminating the assumption of full predictability, consequently introducing tools that allow the so-called reactive "conduction" through which to cope with unpredictable situations. A viable approach to address this challenge is that of digital cloning of physical assets. This allows their relevant behavior to be modeled in a manner suitable for execution by feeding them in real or near real time with data retrieved from the physical world. This approach known as "Digital Twin Modeling" (DT) allows us both to monitor situations, perform analysis and generate insights to predict and optimize its performance and to reflect this knowledge back to it. DT is able to develop a kind of collective intelligence through a large number of heterogeneous

agents that work following stigmergic mechanisms. The resulting data highlight emergent situations and solutions that we cannot predict when we examine each aspect in isolation. In the research proposal, DiTHiCe, DT is exploited as an adaptive system for minor historical centres, as a support to optimize reconstruction processes with a focus on safety responsive management, in order to implement resilience from a smart city perspective. Following this vision, the research project aims to realize a first extensive framework that allows the implementation of digital twins in urban settings by combining different technical and management skills. DiTHiCe will focus on three issues namely "Construction site management and safety", "Management of environmental pollution in the urban area" and "Supply chain management". Subsequently, the project will also realize a first proof of concept by implementing and integrating three different DT demonstrators in the laboratory.

Persone coinvolte

- Valentina Villa (Responsabile Scientifico)
- Erica Lenticchia (Responsabile di progetto (VR, Delegato,...))

Strutture coinvolte

- DISEG - Dipartimento di Ingegneria Strutturale, Edile e Geotecnica

Partner

- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE**
- **Università degli Studi dell'Aquila** - Coordinatore

Parole chiave

Settori ERC

PE8_3 - Civil engineering, architecture, maritime/hydraulic engineering, geotechnics, waste treatment

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 11. Rendere le città e gli insediamenti umani inclusivi, sicuri, duraturi e sostenibili

Budget

Costo totale progetto:	€ 258.777,00
Contributo totale progetto:	€ 184.166,00
Costo totale PoliTo:	€ 68.255,00
Contributo PoliTo:	€ 46.220,00

Ministero dell'Università e della Ricerca

PRIN

PROGETTI DI RICERCA DI RILEVANTE INTERESSE NAZIONALE

Politecnico di Torino

AAGT - Applied Algebraic Geometry of Tensors

Durata:

08/02/2025 - 08/02/2027

Responsabile scientifico:

- Emanuele Ventura

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (MINISTERO DELL'UNIVERSITA' E DELLA RICERCA)

Codice identificativo progetto:

2022NBN7TL

Ruolo PoliTo:

Partner

Abstract

Tensors are higher dimensional matrices and nowadays are ubiquitous throughout science. As for matrices, they are universally useful tools to collect and represent data of any kind. During the last decades, a remarkable amount of activity has been devoted to establishing foundational results on tensors, which in turn are motivated by applications in several areas such as algebraic statistics and complexity of matrix multiplication. Nevertheless, several basic questions remain elusive to this date. The situation is even more convoluted when tensors are defined over the field of real numbers. As a result, research on tensors is blossoming in several directions importing techniques from disparate fields such as algebraic geometry, representation theory, and combinatorics. Decompositions of tensors are convenient and compact ways to express them. Our project aims to study tensor decompositions from a geometric perspective through algebraic geometry and commutative algebra, and consists of four main research directions: P1. Dimensions of secant varieties and general ranks: the knowledge of dimensions of secant varieties allows us to understand when they fill the whole space of tensors of a given format. This says what is the rank of a generic tensor of that format. P2. Spaces of decompositions: It is interesting to study properties shared by all minimal decompositions of a given tensor. These spaces are themselves algebraic varieties. P3. Real ranks: the rank of a tensor depends on the field of coefficients. Over the real numbers, we know very little compared to the case of complex numbers. P4. Algebraic statistics: Several statistical models can be regarded as algebraic varieties parameterised by tensors admitting certain decompositions.

Strutture coinvolte

- DISMA - Dipartimento di Scienze Matematiche "G. L. Lagrange"

Partner

- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE**
- **UNIVERSITA' DEGLI STUDI DI SIENA**
- **UNIVERSITA' POLITECNICA DELLE MARCHE**
- **UNIVERSITA' STUDI TRENTO** - Coordinatore

Parole chiave

Settori ERC

PE1_4 - Algebraic and complex geometry PE1_21 - Application of mathematics in industry and society PE1_14 - Statistics

Budget

Costo totale progetto:	€ 186.347,00
Contributo totale progetto:	€ 164.036,00
Costo totale PoliTo:	€ 48.000,00
Contributo PoliTo:	€ 48.000,00

GOSSIP - Greedy Optimal Sampling for Solar Inverse Problems (GOSSIP)

Durata:

08/02/2025 - 08/02/2027

Responsabile scientifico:

- Emma Perracchione

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Codice identificativo progetto:

2022HFB32T

Ruolo PoliTo:

Coordinatore

Abstract

Given a set of highly sparse data in the Fourier domain, the inversion of the Fourier transform from limited data is a challenging numerical issue whose success strongly depends on the samples' number and location. On the other hand, in real applications, the number and locations of such samples are often constrained by the hardware of the instrument. Hence, the project ambition is to develop numerical schemes based on greedy approaches for an optimal choice of these samples. Such a theoretical study finds a natural application in the field of astronomical imaging. Specifically, space telescopes for solar hard X-ray imaging principally aim at observing big explosions on the solar surface (called solar flares) and providing indirect observations (called visibilities) made of sampled Fourier components of the incoming photon flux. Motivated by the growing interests in the construction of more compact and possibly cheaper satellites (for a general overview, refer e.g. to the European Space Agency - ESA website), the scientific community is currently investigating new technologies for solar nano X-ray telescopes, allowing a continuous flare monitoring. The small shape constraint implies that the telescope would return only a few discrete indirect measurements of the observed flaring events. To ensure reliable scientific results, the number and locations of such samples need to be accurately selected. The Greedy Optimal Sampling for Solar Inverse Problems (GOSSIP) project will thus investigate optimal and highly sparse plausible visibility sampling sets, compatible with the implementation in small satellites. To reach this goal, the GOSSIP researchers will take advantage of the so-called greedy numerical algorithms, properly tailored for the Fourier inversion task, and able to return optimal sampling sets. Hence, having in mind this specific application, the scientific products and expected results consist in: 1) Developing a greedy approach taking into account how the uncertainties on the sample

locations propagate into the process of regularized inversion and image reconstruction 2) Simulating plausible sampling sets for miniature telescopes that, with a few optimal observed visibilities in the Fourier space, are able to provide informative reconstructions of the sought flaring sources. Due to concrete technological constraints on the telescope devices, the sampling in the Fourier space will not be totally free in practice. Therefore, the validation of the so-constructed flare-driven greedy approach will be carried out by considering both synthetic and experimental visibilities as sampled by the ESA telescope Spectrometer/Telescope for Imaging X-rays (STIX) or as observed by the NASA imaging system Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI). The GOSSIP project will thus produce a versatile tool that identifies optimal sparse sampling sets for inverse problems following concrete instrument designs.

Strutture coinvolte

- DISMA - Dipartimento di Scienze Matematiche "G. L. Lagrange"

Partner

- **ALMA MATER STUDIORUM UNIVERSITA' DI BOLOGNA**
- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE** - Coordinatore
- **UNIVERSITA' DEGLI STUDI DI GENOVA**

Parole chiave

Settori ERC

PE1_17 - Numerical analysis PE1_20 - Application of mathematics in sciences

Budget

Costo totale progetto:	€ 222.340,00
Contributo totale progetto:	€ 186.284,00
Costo totale PoliTo:	€ 79.272,00
Contributo PoliTo:	€ 60.372,00

SUPERSONIC - SUPporting Ecological tRanSitiOn iN mId-haul logistiCs

Durata:

08/02/2025 - 08/02/2027

Responsabile scientifico:

- Edoardo Fadda

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Codice identificativo progetto:

2022WXFN5B

Ruolo PoliTo:

Partner

Abstract

The European Environment Agency has recently estimated that about 25% of GreenHouse Gas Emissions (GHGE) in Europe is due to the transportation sector, one of the major sources of environmental pollution. Moreover, the Road Transport (RT) is responsible for about 70% of GHGE due to the transportation sector, emissions forecasted to double in 2050. Therefore, several countries are incentivizing the use of Electric Vehicles (EVs), seen as one promising solution. Moreover, the recent developments in the automotive field have increased the EV drive range (one of the Achilles heels to their diffusion) and allow also partially recharging batteries. For example, a commercial light-duty EV travels without recharging most of a journey in city logistics (distances on average less than 80 km). However, in Mid-Haul Logistics (MHL), where the kilometers covered are usually greater than the drive range of medium-duty commercial EVs, recharges en-route are needed. In addition, Recharging Stations (RSs) are scarcely distributed on the territory, e.g., in Italy, they are concentrated in the North. This may cause (also long) waiting times at RSs that for a company operating in MHL may mean not to serve customers on time, consequently using more EVs leading to an increase in total cost. In this context, SUPERSONIC aims at supporting companies operating in MHL towards an ecological transition, proposing innovative policies to manage public/shared RSs. In all the policies, the availability of a limited number of chargers with possible different kinds of charging technologies (e.g. normal, fast) is considered. In particular, three innovative recharging policies will be introduced, each leading to a different vehicle routing problem: P1 in which RSs are reserved largely in advance, i.e., before starting the trip (leading to time windows at RSs); P2 with an on-line monitoring of the RS occupancy (leading to possible dynamic route changes) and P3 with an instant RS reservation (e.g., at most half an hour in advance

by using an app), i.e., after starting the trip unlike P1. In both P2 and P3, uncertain RS availability is considered since, upon EV arrival, it may be no longer vacant. P1, P2 and P3 are also addressed allowing a battery-based collaboration among EVs of the same fleet, i.e., an EV may recharge another, leading to the versions P1', P2' and P3', respectively. P1 and P1' will be solved by both metaheuristics and matheuristics and bounding techniques to estimate the solution quality will be also proposed. P2, P2', P3 and P3' will be addressed both without historical data, by stochastic and robust optimization and with historical data, properly collected, by innovative approaches combining machine/deep learning with mathematical optimization. SUPERSONIC will contribute to promote smarter RSs with a consequent time savings for companies operating in MHL and to incentivize the use of EVs with consequent positive impacts from a socio-economic point of view.

Strutture coinvolte

- DISMA - Dipartimento di Scienze Matematiche "G. L. Lagrange"

Partner

- **POLITECNICO DI MILANO**
- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE**
- **UNIVERSITA' POLITECNICA DELLE MARCHE** - Coordinatore

Parole chiave

Settori ERC

PE1_21 - Application of mathematics in industry and society PE1_19 - Control theory and optimisation PE1_15 - Discrete mathematics and combinatorics

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 8. Incentivare una crescita economica duratura, inclusiva e sostenibile, un'occupazione piena e produttiva ed un lavoro dignitoso per tutti

Budget

Costo totale progetto:	€ 236.155,00
Contributo totale progetto:	€ 186.142,00
Costo totale PoliTo:	€ 61.254,00
Contributo PoliTo:	€ 56.904,00

Algebraic methods in Cryptanalysis

Durata:

08/02/2025 - 08/02/2027

Responsabile scientifico:

- Carlo Sanna

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Universitá e della Ricerca)

Codice identificativo progetto:

2022RFAZCJ

Ruolo PoliTo:

Partner

Abstract

Cryptographic systems play an increasingly important role in our society in order to secure privacy and confidentiality of communications. A deep cryptanalysis of these systems is really crucial, with the aim of studying their potential weaknesses and highlighting the conditions that allow to attack them. In this way, we are able to provide decisive advices for designing, implementing and using effectively safe ciphers. The continuous advancement of the modern cryptographic systems makes cryptanalysis one of the most active research fields that deserves to be widely studied. It is well known that cryptography and cryptanalysis are mainly based on pure mathematics and specifically on algebra and number theory, think to the importance of elliptic curves, finite fields, group theory and polynomial systems. This project aims at obtaining new results in the field of cryptanalysis with innovative methodologies that may open new research directions. Attention will be paid to cryptanalysis of both symmetric and asymmetric schemes, with the goal to also apply the theoretical results to the lightweight cryptographic systems and post-quantum systems currently submitted to the NIST competitions. Lines of research are the following: - Algebraic cryptanalysis for stream, block and public key ciphers is essentially based on solving involved polynomial systems over finite fields. The complexity to perform such solving is an assessment of the security of the corresponding ciphers. Many approaches are possible to such tasks such as symbolic computation, satisfiability checking, binary decision diagrams, etc. In this project we will develop symbolic computation, namely Grobner bases, having in mind that smart guess-and-determine strategies are a key tool to provide not only theoretical but also practical complexity. - The conjugacy class of elementary abelian regular subgroups of the symmetric group has recently drawn the attention of symmetric cryptographers, as these subgroups and their normalizers may be used to detect weaknesses in symmetric-encryption methods. For this reason one of the goals of this project is to

obtain a deeper knowledge of the structure of such subgroups suitable for cryptanalysis - In the elliptic curve cryptography, anomalous curves are not recommended due to attacks based on a lift in the field of p-adic numbers and a p-adic elliptic logarithm. These strategies may inspire similar attacks for other classes of curves, in particular studying if the lift of a curve into rings might imply a flaw in cryptographic protocols. Other classical asymmetric schemes can be attacked exploiting properties of continued fractions, we aim at creating new attacks using multidimensional continued fractions - We propose to search for new structured groups with algorithms for the Hidden Subgroup Problem that are time-efficient, space-efficient, or both, with particular attention to cases related to the security of classical and post-quantum cryptosystems

Strutture coinvolte

- DISMA - Dipartimento di Scienze Matematiche "G. L. Lagrange"

Partner

- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE**
- **Università degli Studi dell'Aquila**
- **UNIVERSITA' DEGLI STUDI DI BARI ALDO MORO**
- **UNIVERSITA' DEGLI STUDI DI MILANO**
- **UNIVERSITA' STUDI TRENTO** - Coordinatore

Parole chiave

Settori ERC

PE1_2 - Algebra PE6_5 - Cryptology, security, privacy, quantum crypto

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 9. Costruire un'infrastruttura resiliente e promuovere l'innovazione ed una industrializzazione equa, responsabile e sostenibile

Budget

Costo totale progetto:	€ 237.464,00
Contributo totale progetto:	€ 185.944,00
Costo totale PoliTo:	€ 47.492,00
Contributo PoliTo:	€ 37.188,00

Virtual music visualisation processes. Research, methodology and innovative technology in the didactics of listening.

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Sergio Pace

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Codice identificativo progetto:

2022MEP5BC

Ruolo PoliTo:

Partner

Abstract

La ricerca sarà dedicata al tema della visualizzazione virtuale della musica strumentale, con la finalità di individuare e sperimentare metodologie innovative nella didattica dell'ascolto. Il progetto nasce da una riflessione interdisciplinare che coinvolge pedagogia musicale, storia dell'architettura, storia dell'informatica e interaction design, a partire da modelli già sperimentati all'interno di processi educativi sulla visualizzazione, reale o virtuale, di plot narrativi. La finalità pedagogica si abbinerà all'intenzione di dotare gli utenti, sia in fase di orientamento (docenti) che di restituzione (i discenti), di conoscenze e strumenti utili per l'elaborazione digitale di oggetti spaziali tridimensionali, destinati a rappresentare concetti, forme, idee, procedimenti adottati dal compositore. Il principio-guida sarà il progetto e la realizzazione di raffigurazioni grafiche, alternative alla notazione scritta ma efficaci per offrire una rappresentazione virtuale della musica consapevole e insieme creativa.

Strutture coinvolte

- DAD - Dipartimento di Architettura e Design

Partner

- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE**

- **UNIVERSITA' DEGLI STUDI DI TORINO** - Coordinatore

Parole chiave

Settori ERC

PE6_1 - Computer architecture, pervasive computing, ubiquitous computing SH5_5 - Music and musicology; history of music SH5_6 - History of art and architecture, arts-based research

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 4. Fornire un'educazione di qualità, equa ed inclusiva, e opportunità di apprendimento per tutti

Budget

Costo totale progetto:	€ 222.539,00
Contributo totale progetto:	€ 182.749,00
Costo totale PoliTo:	€ 110.080,00
Contributo PoliTo:	€ 89.080,00

EVER EARTH - Enhance VERnacular EARThen Heritage: strategies to promote conservation, reuse, and new development

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Manuela Mattone

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Codice identificativo progetto:

2022H2YH2F

Ruolo PoliTo:

Coordinatore

Abstract

Vernacular architecture is the successful result of centuries of progressive improvements, adaptations of the construction culture to environmental conditions, local resources availability and social constraints. Unfortunately, nowadays, this heritage is threatened with extinction everywhere. Preserving and transmitting material testimonies, as well as technical knowledge, are the fundamental actions needed to safeguard the vernacular constructive culture, therefore, its values of civilisation. However, these actions are strictly connected to the recognition of its tangible and intangible values, and to the identification of sustainable intervention methods, in order to safeguard it from anthropic (the lack of maintenance, decay, inappropriate interventions, people's perception, etc.), natural-related conservation problems (as water and wind erosion, earthquakes, etc.). The numerous earthen constructions in several countries are an integral part of the vernacular heritage. Widely spread in many countries all over the world, earthen constructions constitute a testimony of knowledge, skills, and human adaptation to a specific natural habitat. Nonetheless, this heritage is today at risk worldwide. On the one hand, considered unhealthy and unsafe, and incompatible with the concept of modernity, earthen vernacular architectures have been gradually abandoned. On the other hand, the push for modern building techniques has impacted the transmission of knowledge and skills, thus causing the lack of maintenance or unsustainable interventions. The Enhance VERnacular EARThen Heritage (EVER EARTH) project intends to examine the strengths and weaknesses of the actions implemented so far to safeguard and promote the reuse of vernacular earthen architecture and to propose versatile intervention methodologies that can be replicated in

other contexts. In this perspective, it is of particular interest to analyse the situation in Piedmont, which is characterised by the presence of a rich earthen heritage and has been the protagonist of specific interventions of preservation and recovery, thanks not only to the work of cultural associations but also to the issuing of regional law 2/2006. More than 15 years after its enactment, it is important and useful not only to evaluate the results of the interventions carried out and to capitalise on the results but also to study in-depth the risks to which the earthen heritage is subjected and to outline strategies that, applicable also in other contexts and for similar heritage, will contribute to the effective conservation and reuse of architecture and the rural landscape in line with the missions "Digitalisation, innovation, competitiveness, culture and tourism" and "Green revolution and ecological transition" of the National Recovery and Resilience Plan.

Persone coinvolte

- **Manuela Mattone** (Responsabile Scientifico)
- **Luca Davico** (Componente gruppo di Ricerca)
- **Francesca Thiebat** (Componente gruppo di Ricerca)
- **Marco Zerbinatti** (Componente gruppo di Ricerca)
- **Sara Fasana** (Responsabile Scientifico di Struttura)
-

Strutture coinvolte

- DAD - Dipartimento di Architettura e Design
- DISEG - Dipartimento di Ingegneria Strutturale, Edile e Geotecnica
- DIST - Dipartimento Interateneo di Scienze, Progetto e Politiche del Territorio

Partner

- **C.N.R. - CONSIGLIO NAZIONALE DELLE RICERCHE**
- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE** - Coordinatore
- **UNIVERSITA' DEGLI STUDI DI FIRENZE**

Parole chiave

Settori ERC

SH5_8 - Cultural studies, cultural identities and memories, cultural heritage SH2_7 - Environmental and climate change, societal impact and policy

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 11. Rendere le città e gli insediamenti umani inclusivi, sicuri, duraturi e sostenibili

Budget

Costo totale progetto:	€ 347.115,00
Contributo totale progetto:	€ 248.686,00
Costo totale PoliTo:	€ 155.840,00
Contributo PoliTo:	€ 95.163,00

AMIM - Architects and Master Builders in Medieval Italy

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Carlo Mario Tosco

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (MUR)

Codice identificativo progetto:

2022YXESH7

Ruolo PoliTo:

Coordinatore

Abstract

The aim of the project is to deepen our knowledge of the architects and builders working in medieval Italy. Our country represented a space of experimentation and development of the figure of the architect in the European framework, from the 11th century to the Gothic age. In Italy, in fact, the sources present the most celebrated architects of the Romanesque period, such as Buscheto in Pisa and Lanfranco in Modena, personalities who emerged from the traditional anonymity of the building trade and distinguished themselves as high-level professional figures. This affirmation takes place in the context of the Italian communal civilization, where institutions promoted public works and recognized the dignity of work at the service of the urban community. Later, narrative, epigraphic and administrative sources allow us to follow the development of professional activities in the building sector and to know new figures of architects who marked the history of the art of building in Italy. In the South, significant information emerges already during the Norman reign, which intensifies with the imperial rule of Frederick II. In the Angevin kingdom of Naples a vast availability of administrative sources makes it possible to get in touch with the organization of construction sites in the capital and in the main cities, the division of labour and the most important figures of directors of construction sites, operating in a highly specialized context, in relation with masters from France. In central and northern Italy between the 13th and 14th centuries, the Communes and the Seigneuries established privileged relationships with the most famous architects, responsible for the building sites promoted by the civil authorities. A large amount of information is handed down by the administrative documentation promoted by the Italian Ministero dell'Università e della Ricerca MUR - BANDO 2022 municipalities, which still awaits a systematic comparative examination. Studies on these historical processes and on the affirmation of the figure

of the architect in the Italian late Middle Ages require a new in-depth study and an updating of the investigations. The role of the architect, the organization of the building sites, the specialization of the workers in the different building sectors, is a task of capital importance for a new understanding of Italian architecture from the Romanesque to the Gothic age. Research to date is fragmentary and mainly monographic in nature, while an overall reading of this long process of development is lacking. The project gathers the main scholars who, at a national level, have carried out research in this field. The coordination of investigations, the sharing of research methods, the exchange of information among the team members, the database repertory on line and the open access publication of results, are the most significant strengths of the project.

Strutture coinvolte

- DIST - Dipartimento Interateneo di Scienze, Progetto e Politiche del Territorio

Parole chiave

Settori ERC

SH5_6 - History of art and architecture, arts-based research

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 11. Rendere le città e gli insediamenti umani inclusivi, sicuri, duraturi e sostenibili

Budget

Costo totale progetto:	€ 231.464,00
Contributo totale progetto:	€ 186.387,00
Costo totale PoliTo:	€ 136.464,00
Contributo PoliTo:	€ 111.464,00

Italia ’90 atlas. History, impact and legacy of the Football World Cup

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Elena Dellapiana

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Codice identificativo progetto:

20227HM5FY

Ruolo PoliTo:

Partner

Abstract

Attraverso lo sviluppo di una conoscenza capillare dell’evento Italia ’90 sotto molteplici aspetti, lo scopo del progetto è giungere a ricomporre un atlante della fenomenologia dei Mondiali di Calcio suscettibile di essere valorizzato in contesti reali o virtuali, ed interrogarsi, al contempo, sul lascito del fenomeno per approdare, in ultima analisi, a proposte progettuali con particolare riferimento alle strutture sportive e al loro rapporto con la città, che possano costituire la base d’intervento per l’organizzazione di futuri articolati e organici eventi di grande respiro internazionale, come giochi olimpici, paraolimpici, campionati europei e mondiali di diverse discipline.Per la natura sfaccettata di un evento come Italia ’90, la ricerca ha un carattere interdisciplinare. Il progetto è infatti concepito e sarà condotto da un gruppo di studiosi impegnati in diversi ambiti: storici, economici, socio-antropologici, della storia dell’architettura e del design, della tecnologia e della costruzione, del progetto architettonico nelle sue varie declinazioni. Il workflow si svolgerà in quattro fasi: la prima storico-analitica indagando i seguenti nuclei tematici e le relative fonti: politica e società, economia e cultura, architettura e urbanistica, design e comunicazione; la seconda di selezione e ricomposizione dei contenuti di un atlante per la valorizzazione di Italia ’90; la terza di interrogazione e interpretazione critica dei dati per comprendere quale sia l’impatto e l’eredità di Italia ’90 in tutte le sue sfaccettature, con una uscita finale specifica sul tema degli stadi; la quarta di declinazione progettuale prettamente riferita agli stadi. La proposta di ricerca intende dare forma concreta al processo di transizione tra la fase istruttoria del progetto e la fase di formalizzazione e sintesi dello stesso. Alla luce dunque di una capillare conoscenza di ciò che ha comportato il fenomeno-globale Italia ’90, i risultati della ricerca apporteranno nuove prospettive e nuove competenze alle numerose attuali analisi di intervento circa la riqualificazione degli impianti

italiani. Si determineranno ponderate proposte-guida di miglioramento delle strutture esistenti, così da porre le basi per la costruzione di efficaci sinergie tra pubblico e privato, in grado di offrire agli stakeholders condizioni adeguate a sostenere gli investimenti economici necessari

Strutture coinvolte

- DAD - Dipartimento di Architettura e Design

Partner

- **POLITECNICO DI BARI**
- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE**
- **UNIVERSITA' DEGLI STUDI DI FIRENZE** - Coordinatore
- **UNIVERSITA' DI FERRARA**

Parole chiave

Settori ERC

PE8_3 - Civil engineering, architecture, maritime/hydraulic engineering, geotechnics, waste treatment SH5_8 - Cultural studies, cultural identities and memories, cultural heritage SH5_6 - History of art and architecture, arts-based research

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 11. Rendere le città e gli insediamenti umani inclusivi, sicuri, duraturi e sostenibili

Budget

Costo totale progetto:	€ 277.238,00
Contributo totale progetto:	€ 188.719,00
Costo totale PoliTo:	€ 69.237,00
Contributo PoliTo:	€ 52.839,00

MASTER - Magnetic responsive smart device for tendon regeneration (MASTER)

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Roberto Pisano

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Codice identificativo progetto:

20224CRCCK

Ruolo PoliTo:

Partner

Abstract

Tendon injuries frequently require surgical treatment, and, despite recent advancements in orthopedic surgery, they yield less than optimal results and present the risk of microbial colonization, since the devices used could trigger biomaterial-related infections and biofilm formation. Furthermore, healed tendons tend to form scar tissue with different mechanical properties than healthy ones and are prone to re-injury due to their lack of native tissue complexity. Since tendons are force transmitters and mechanoresponsive tissues, cells within the tendon tissues perceive a complex microenvironment where both environmental cues and cellular mechanotransduction are pivotal in different cell responses, such as apoptosis, proliferation, migration, and differentiation. Recently, biomechano-responsive materials are emerging in tendon tissue engineering. The synergism of stimuli-responsive biomaterials and mechanical stimuli seems fundamental as teno-inductive cues to boost tendon healing. From this perspective, magneto-responsive medical devices (as tendon substitutes) and magnetotherapy should serve as mediators of mechanotransduction to enhance tendon regeneration. The aim of the project is the design and the development of biomechanic-responsive 3D scaffolds able to improve surgical repair or reconstruction of tendons/ligaments. Thermoplastic polymers (polyurethane and polyacrylcyanoacrylate) will be associated with chondroitin sulfate to obtain slow reabsorption (degradation) to guarantee the scaffolds to support the mechanical load until the regeneration of the new tissue is completed. Lyophilized (sponge-like) or electrospun scaffolds will be doped with magnetic iron oxide nanomaterials to obtain a hierarchical structure, responsive to magnetotherapy. The activation of the iron oxide nanomaterials should act as a mediator of mechanotransduction to remotely deliver mechanical stimulation directly to the cells. This should boost tendon healing by

achieving teno-inductive cues. Magnetite nanoparticles, the benchmark, and Fe-Mg-hydrotalcites will be compared to evaluate the in vitro efficacy and safety profiles. The 3D scaffolds will be manufactured using both freeze-drying and electrospinning, well-known techniques to obtain hierarchically structured scaffolds for tissue engineering. The two approaches will enable the production of different structures. The sponge-like matrix will be an interconnected structure with pores while the nanofibrous scaffolds will consist of entangled fibers given a certain porosity. Considering these, the mechano stimulation could be differently transmitted to the surrounding and to the infiltrated cells depending on the structure stiffness. Moreover, the reproducibility and the robustness of the manufacturing procedure and the identification of the quality attributes to assure reproducibility of the scaffold will be considered.

Strutture coinvolte

- DISAT - Dipartimento Scienza Applicata e Tecnologia

Partner

- **AIMETA - UNIVERSITA' DI PAVIA** - Coordinatore
- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE**
- **Università degli studi di milano**
- **Università degli studi di torino**

Parole chiave

Settori ERC

LS7_4 - Analgesia and Surgery LS7_3 - Pharmacology, pharmacogenomics, drug discovery and design, drug therapy LS7_6 - Gene therapy, cell therapy, regenerative medicine

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 3. Assicurare la salute e il benessere per tutti e per tutte le età

Budget

Costo totale progetto:	€ 207.600,00
Contributo totale progetto:	€ 180.600,00
Costo totale PoliTo:	€ 48.156,00
Contributo PoliTo:	€ 41.300,00

NINFEA - Non INvasive FibEr type Assessment in skeletal muscle through advanced diffusion and perfusion MRI

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Giuseppe De Nisco

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Ruolo PoliTo:

Partner

Abstract

Skeletal muscle (SM) is the most abundant tissue in the human body and plays important roles in relevant functional aspects (e.g., movement, posture, and balance under voluntary control). SM is composed of myofibers that are broadly classified into slow twitch (Type I) and fast twitch (Type II) fibers. SM fiber types can have a profound impact on physio-pathological conditions affecting SM – such as sarcopenia in aging people or induced by spinal cord injury, or even more severe neuromuscular diseases like dystrophies - and their study can improve the diagnosis/prognosis of such conditions. In particular, SM microstructure assessment can help improve rehabilitation programs and exercise training effectiveness, thanks to a more personalized intervention.

Currently, the gold standard approach to study SM fiber composition is invasive and needs the use of biopsy to obtain biological samples to be further analyzed through histology and immunohistochemistry procedures. The idea of this project is to propose Magnetic Resonance Imaging (MRI), with its advanced diffusion and perfusion techniques, as a non-invasive tool for muscle microstructure study. Proper modeling of perfusion and diffusion processes in SM could allow defining an MR acquisition/processing protocol able to exploit type I and II fibers' morphological and functional differences, particularly in size and number of bedewing capillaries. Most of the advanced MRI tools are currently focused on central nervous system applications and optimized for that target. Some promising MRI techniques have been recently proposed to characterize SM in terms of its microstructural properties related to diffusion and perfusion, but their ability to unravel the actual fiber type composition is still suboptimal.

Within the PNRR framework that fosters interactions between research institutions and universities, young researchers' involvement, basic research for new technologies with a focus on health, the

NINFEA project aims at exploring novel MR methods based on joint diffusion and perfusion parameters for SM fibers characterization with a potential impact on the optimization of rehabilitation for functional recovery. NINFEA involves a CNR and two complementary academic units, headed by under 40 researchers; the recruitment of four junior fellows is expected. During the project, at first, state-of-the-art models will be exploited and estimated parameters will be integrated through a multivariate regression on type I/II fiber percentage. Furthermore, novel multicompartment multivariate models explicitly modeling type I/II fibers contribute to diffusion and perfusion will be proposed and used to develop novel ad-hoc data acquisition and processing protocols. Preclinical high field MRI sessions will be conducted to optimize pulse sequences and validate the developed methodologies. Finally, a feasibility study in a clinical scenario using a 3T MRI scanner will be performed.

Strutture coinvolte

- DIMEAS -Dipartimento di Ingegneria Meccanica e Aerospaziale

COMbined biomarker criteria for coronary atherosclerotic Plaque rUpTurE aSsessment (COMPUTES)

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Umberto Morbiducci

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Ruolo PoliTo:

Partner

Abstract

Cardiovascular disease is the leading cause of death and disability, with prevalent cases doubling in the past decades and the number of deaths steadily increasing. Identification of patients at high risk of cardiovascular events for intensive management of risk factors and stratified pharmacotherapy is key to addressing this societal burden, which would also lead to a reduction in

unnecessary procedures and examinations. However, identifying patients at risk of cardiovascular events is highly challenging: atherosclerotic plaques may cause acute myocardial infarction, but can also heal without causing an event. In addition, current risk stratification based on imaging and known biomarkers is suboptimal due to the multifactorial nature of the disease. The objective of this proposal is to develop a multicriteria decision model for the non-invasive assessment of vulnerable atherosclerotic patients and to evaluate its ability to predict the occurrence of an adverse event in intermediate-to-high risk patients with suspected or known coronary artery disease. The planned workflow combines plaque imaging with biomechanical assessment to derive the most accurate risk stratification model. Coronary computed tomography angiography (CCTA) will be used to assess high-risk plaque features and extract current clinical plaque features (e.g., thin fibrous plaque, positive remodelling index, plaque burden, low-attenuation plaque, and napkin-ring sign), as well as to build computational models for structural and fluid dynamics analyses. Optical coherence tomography (OCT) images will be used for consistency check of the predicted results. Plaque features, biomechanical indices, and the patient's medical history will be integrated to generate machine learning models for the presence of CCTA-defined high-risk plaques. Advanced classification techniques, including Support Vector Machines, Discriminant Analysis and Artificial Neural Networks, will be deployed. The developed tool will be validated in an independent patient cohort to assess the robustness and reliability of the proposed solution. Integrated predictive tools

developed in COMPUTES may promote personalised approaches to ischemic heart disease in both its early and advanced stages. Specifically, in primary prevention settings COMPUTES will help the physician to better identify patients who will benefit the most from preventive treatments. In secondary prevention settings, identification of patients with a worse prognosis may prompt the clinician to more intensive surveillance. Overall, this may lead to a further reduction in cardiovascular events and hospitalization, including sequelae and late complications like heart failure, which in turn represents an important cost for the National Health Care System.

Strutture coinvolte

- DIMEAS -Dipartimento di Ingegneria Meccanica e Aerospaziale

FArmer robots: safe, sustainable and efficient precision agriculture in highly Challenging Environments

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Giuseppe Quaglia

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Ruolo PoliTo:

Partner

Abstract

For the next generation of farmer robots, it is critical to address open challenges towards safe and efficient deployment in highly challenging environments. Precision Agriculture tasks like crop monitoring, spraying, weeding, canopy management as well as different agronomic conditions could require working in different modalities. This is especially true on steep and rugged terrains where novel solutions need to be found for efficient and safe locomotion as well as to increase the level of autonomy for long duration applications. Within the FACE project, three main issues for electrically driven agricultural robots will be directly tackled: traction control, terrain awareness and rollover mitigation. Off-road vehicles adopt usually multiple driven axles, thus, calling for a suitable control strategy that minimizes energy consumption by preventing wheel slippage while ensuring optimal traction and steerability performance even in the presence of narrow sloped passages and steering through crop rows. In addition, enabling a farmer robot

with the ability to sense the traversed terrain would make it possible to optimize its locomotion performance by implementing site-specific control and planning strategies. In contrast to existing methods that mostly rely on forward imaging sensing failing to provide any information about the mechanical properties that directly impact on vehicle mobility, in the context of FACE the ambition is to rely on proprioceptive sensors (e.g., accelerometers and torque sensors). The envisaged idea is that terrain category can be identified using wheels/tracks as tactile sensors that generate signals modulated by the vehicle-terrain interaction. Increasing robot awareness on the rollover risk and implementing safety measures is another key issue. Current efforts have been devoted to safety systems for tractors focusing on dynamic simulations and rather simple rollover indicators.

However, much research has to be developed yet: episodes of impending tire contact loss have to be recognized and treated, and dynamic indicators as well as

correction actions, e.g., active steering and body reconfiguration, are new areas of investigation. One important aspect of the FACE project is that it will cover both theoretical and experimental research. On the one hand, activities will be devoted to understanding the fundamental physical mechanisms underlying robot-environment interaction, and to the development of physical models and estimation methods that allow automated machines to operate efficiently and safely in complex unstructured scenarios. On the other hand, rigorous experimental analysis and demonstration will be performed leveraging on existing partners' robots and facilities. One unique feature is the use of heterogeneous farmer robots including multi-wheeled, tracked and reconfigurable articulated prototypes, which gives the opportunity to demonstrate the scalability and general applicability of the proposed technologies.

Strutture coinvolte

- DIMEAS -Dipartimento di Ingegneria Meccanica e Aerospaziale

Ministero dell'Università e della Ricerca

PRIN

PROGETTI DI RICERCA DI RILEVANTE INTERESSE NAZIONALE

Politecnico di Torino

Resilience against Cyber Threats for Plant Integrity and Worker Safety in Process Industry

Durata:

04/02/2025 - 03/02/2027

Responsabile scientifico:

- Micaela Demichela

Tipo di progetto:

Ricerca Nazionale - PRIN

Ente finanziatore:

MINISTERO (Ministero dell'Università e della Ricerca)

Ruolo PoliTo:

Partner

Abstract

Il progetto mira a proporre una cassetta degli attrezzi come supporto per il sistema di risposta agli incidenti (IRS) incentrato sulle minacce informatiche. La soluzione proposta sarà in grado di identificare tempestivamente le minacce informatiche, stabilire priorità immediate e garantire un adeguato livello di resilienza. Il progetto si concentra sullo sviluppo di una soluzione in grado di supportare l'identificazione, il contrasto e la gestione di tali rischi. Verranno sviluppati approcci multi criterio per affrontare i domini della sicurezza, dell'affidabilità e dei costi, considerando la natura multiforme del problema. Tradotto con DeepL.com (versione gratuita)

Strutture coinvolte

- DISAT - Dipartimento Scienza Applicata e Tecnologia

Partner

- **ALMA MATER STUDIORUM UNIVERSITA' DI BOLOGNA**
- **POLITECNICO DI TORINO - AMMINISTRAZIONE CENTRALE**
- **Università "Campus Bio-Medico" di ROMA** - Coordinatore

Parole chiave

Settori ERC

PE8_2 - Chemical engineering, technical chemistry

Obiettivi di Sviluppo Sostenibile (Sustainable Development Goals)

Obiettivo 8. Incentivare una crescita economica duratura, inclusiva e sostenibile, un'occupazione piena e produttiva ed un lavoro dignitoso per tutti

Budget

Costo totale progetto:	€ 236.277,00
Contributo totale progetto:	€ 184.928,00
Costo totale PoliTo:	€ 77.552,00
Contributo PoliTo:	€ 60.698,00