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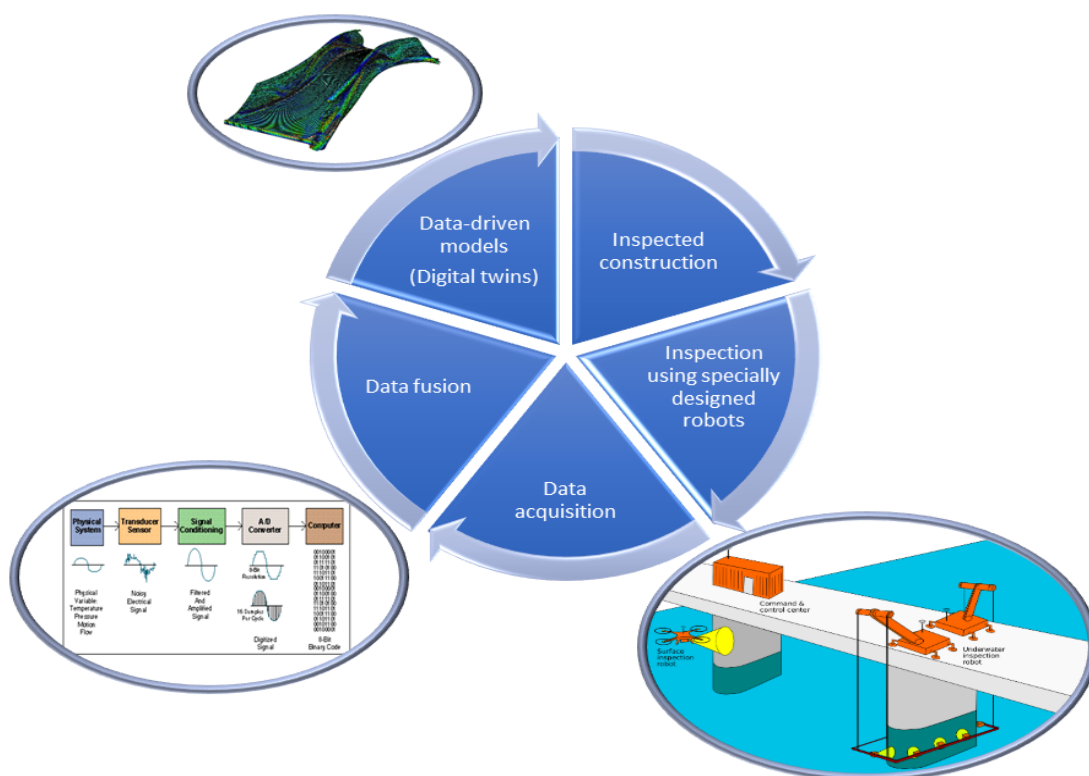
# IRIS - Inspection and security by Robots interacting with Infrastructure digital twinS

Research Project funded by  
NATO Emerging Security Challenges Division Science for Peace and Security (SPS)  
Programme

January 14 – 20, 2023

## **IRIS 1<sup>st</sup> year hybrid meeting**

Universiapolis - International University of Agadir (Morocco)  
and remote





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## MEETING AGENDA

Join Google Meet [meet.google.com/isn-mskf-far](https://meet.google.com/isn-mskf-far)

Saturday-Monday, January 14th-16th, 2023

IRIS Project 1<sup>st</sup> year meeting

Optional visit in South of Morocco, technical visit to university facility

Monday, January 16<sup>th</sup>, 2023

IRIS Project 1<sup>st</sup> year meeting

10:00 AM Arrival and registration of participants

Tuesday, January 17<sup>th</sup>, 2023

IRIS Project 1<sup>st</sup> year meeting

10:00 AM Welcoming coffee and tea

10:15 AM **Recup of the report of the milestone 1** - achieved outcomes, problems - responsible prof. Dvorak

11.30 AM **Challenges for milestones 2** - deadlines, outputs, current situation, problems - responsible prof. Figuli

12:45 AM Lunch break

2:00 PM **Meeting of working group responsible for WP1, WP2** - responsible prof. Wojtowicz

4:00 PM Website appointment

4:30 PM Conclusion of the day

Wednesday, January 18<sup>th</sup>, 2023



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## IRIS Project 1<sup>st</sup> year meeting

### Technical visit - Prince Moulay Abdellah Dam

<b>9:00 AM</b>	<b>Meeting point and starting</b>
<b>11:00 AM</b>	<b>Arrival and technical visit</b>
<b>1:00 PM</b>	Lunch break
<b>2:30 PM</b>	<b>Return journey</b>
<b>7:00 PM</b>	<b>Social dinner</b>

Thursday, January 19<sup>th</sup>, 2023

## IRIS Project 1<sup>st</sup> year meeting

<b>10:00 AM</b>	Welcoming coffee and tea
<b>10:15 AM</b>	Working meeting: Preparing Technical report of Case studies <b>Case studies in Italy</b> - responsible prof. Gattulli/Rinaldi
<b>11:00 AM</b>	<b>Case studies in Slovakia</b> - prof. Papán
<b>12:00 AM</b>	<b>Case studies in Morocco</b> - prof. Bendarma
<b>12:45 AM</b>	Lunch break
<b>2:00 PM</b>	<b>WP2 Design and development of robotic solutions for automatic or guided inspection</b> - responsible prof. Ottaviano/ prof. Wojtowicz Working meeting: Solution developed for the cases of study
<b>3:30 PM</b>	Coffee break
<b>4:00 PM</b>	<b>WP4: Telemetry and data collection</b> - prof. Daponte Working meeting: Solution developed for the cases of study
<b>6:00 PM</b>	Conclusion of the working day

Friday, January 20<sup>th</sup>, 2023



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IRIS Project 1 <sup>st</sup> year meeting	
<b>10:00 AM</b>	Welcoming coffee and tea
<b>10:15 AM</b>	<b>Dissemination activities plan, quality plan, financial management plan</b> - current conditions and problems - responsible prof. Ottaviano
<b>11:00 AM</b>	Working on the common scientific paper <b>“A survey on technology for inspection and security by autonomous systems interacting with infrastructure digital twins”</b> part:  <ol style="list-style-type: none"><li><b>1. Definition of Building Information Modeling (BIM) and Digital Twin (DT)</b> - responsible prof. Papán</li><li><b>2. Autonomous systems and sensors</b> - responsible prof. Ottaviano</li></ol>
<b>12:45 AM</b>	Lunch break
<b>2:00 PM</b>	Working on the common scientific paper <b>“A survey on technology for inspection and security by autonomous systems interacting with infrastructure digital twins”</b> part:  <ol style="list-style-type: none"><li><b>3. Data acquisition and processing</b> - responsible prof. Daponte (De Vito?)</li><li><b>4. Structural Health Monitoring</b> - responsible prof. Gattulli</li><li><b>5. Security of infrastructure</b> - responsible prof. Dvorak</li></ol>
<b>4:00 PM</b>	Closing of activities

Saturday, January 21<sup>st</sup>, 2023

## IRIS Project 1<sup>st</sup> year meeting

Delegate's Departure



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## PROJECT OVERVIEW

### Description

Survey, inspection, maintenance, construction and restoration have become challenging activities conducted during the process of civil infrastructure management, due to the revolutionary impact of mechatronics and information technology for their automation. The core of the proposed IRIS project relates to the development of new technologies to fully automate the use of robotized systems and sensor networks in data acquisition for survey, inspection and monitoring. The interaction between data acquisition and storage is managed by the construction of advanced models which are the Digital Twins (DT) of the infrastructure updated in real time. For the continuous Non-destructive Evaluation (NDE) of the infrastructure, the integration of different information, the so-called data fusion process, is used to develop powerful digital models providing an exhaustive and realistic description of the examined facility during its service life even in post-disaster occurrences. Data and models provide the basis to identify and to describe defects and degradation especially in view of determining possible performance reduction in existing structures. All the acquired knowledge, opportunely managed, constitutes the input for automated or partially automated decision-making processes useful in facilities and infrastructure management.

### Goals

Existing structures need inspections to detect possible deterioration and to program their maintenance. Inspections could be initial inspections, routine inspections, damage inspections, in-depth inspections, fracture-critical inspections, underwater inspections, and special inspections. The final goal of all of them is to extend the construction life and avoid critical failure. However, considering that different size, geometry, complexity of conservation, environmental conditions, etc., are present in steel constructions, designing automated procedures to execute these inspections and maintenance is a challenging matter.

IRIS aims at looking at the available data extractable by the mostly updated monitoring systems in order to develop innovative strategies usable for a large number and variety of structures and based on automatic acquisition, digital image processing and data fusion.

In this area IRIS project aims to develop novel concepts for the proposed technological platforms, the sensor modalities and the data analysis techniques. The development of procedures for the use of robots and automatic systems and their integration with standard SHM deployment will go a step beyond the current state-of-art in this specific field with relevant practical outcomes, especially due to a spread use of the proposed approach for several types of different structures.

In particular, the development of novel methodology to construct and interact with the digital twins of the studied infrastructure is found the novel idea of the proposal which aims to: i) enhance the penetration of novel structures into the market through the use of sensing and automation for self-inspection interacting with the digital twins that follow the entire project from the beginning; ii) enlarge structural life of new and existing structures; iii) increase the safety of human operators with sustainable costs.

### Expected Results

The project will result in the proposed new integrated system for automatic inspection, maintenance and security of infrastructures. Additionally, the Master of Science Programme in Analysis, diagnostics and monitoring of structures and infrastructures founded in 2019 in Sapienza will be proposed at the international level thanks to the NATO support, to uniquely embrace new knowledge in preventing failure in on-shore and off-shore strategic infrastructure.



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## PARTICIPATING INSTITUTIONS

Sapienza  
University  
of Rome  
Italy

**Sapienza University of Rome** (SAPIENZA) with over 700 years of history, over 113,000 students, 3,300 teachers and 2,000 employees, technicians, and librarians, in addition to 1,800 administrative staff in university hospitals, **Sapienza** is the first university in Europe. Its mission is to contribute to the development of a knowledge society through research, excellence, quality education and international cooperation. In this context, five Nobel Prize winners and a large number of internationally renowned scientists have taught and/or studied at Sapienza.

Scientific research activity at Sapienza covers an extremely broad spectrum of disciplines, reaching levels of excellence in many areas, including archaeology, physics and astrophysics, humanities and cultural heritage, the environment, nanotechnologies, cell and gene therapy, design, aerospace, social and economic sciences.

The **Department of Structural and Geotechnical Engineering** (DISG) of the Faculty of Civil and Industrial Engineering, Sapienza University of Rome has a distinguished history and a tradition of excellence in teaching, research, and services dating back to 1873. There are three main broad research areas: Solids and Structural Mechanics, Structural Engineering, and Geotechnical Engineering.

DISG's academic and research activities have attained an international reputation for excellence in areas such as structural dynamics and control, earthquake engineering, risk analysis, full-scale monitoring, behaviour of structural and geotechnical systems (galleries, tunnels), structural analysis and design, smart structures, and the structural reliability of historic buildings and monuments.

Universiapolis  
International  
university  
of Agadir  
Morocco

The International University of Agadir – **Universiapolis**, was built in 2010 in the new university zone of the city of Agadir on an area of 6 Ha and with a modern and integrated architecture. The campus was built with a design that provides students with an integrated, user-friendly infrastructure with all the necessary local services.

The campus includes the four institutions under the University, a common library, a university residence, a technology hall, a research centre, a congress hall and several spaces and sports fields. The campus was built in compliance with safety, health and accessibility standards. The International University of Agadir was created 30 years ago and today has 4 graduate schools. It is recognized for the excellence of its innovative North American teaching methods, as well as for its exceptional university campus ... Since its creation, Universiapolis opted for an international openness. This desire has materialized through the development of cooperation and exchange agreements with various universities in North America, Europe and Asia. The Materials, Environment and Renewable Energies research team works in complementary fields applying to metallic materials, reinforced polymers, and biomaterials applied in different fields. But also on new technologies of renewable energies and environmental protection, the team combines modelling and experimental approach and relies on solid generic and multidisciplinary skills (physic-chemistry of materials, process engineering, heat transfers, mechanics fluids, electrical engineering, applied mathematics, statistics): contribution to the improvement of tools for dimensioning structures, numerical modelling combined with statistical methods, renewable energies, processes and environment.

University of  
Sannio

The **University of Sannio** (UNISANN) is organized in 3 Departments (Department of Engineering, Department of Law, Economics, Management and Quantitative Methods, Department of Science and Technology), providing 12 BSc, 12 MSc. and 5 Ph.D. courses to about 8000 enrolled students. Within the University of Sannio, the mission of the Department of Engineering is to promote, to organize and to manage the scientific and technological research to support the educational offer of the University. The Department manages the courses in the scientific areas for degrees in Engineering. The Department of Engineering operates in the fields of civil and environmental engineering, industrial engineering and information engineering. The task of the teachers and the researchers is to disseminate new knowledge in collaboration with the national and international scientific community, with the enterprises world and the local authorities.



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The **Department of Engineering** coordinates research structures, activities and programs, while respecting the scientific autonomy of the teachers and researchers and in respect of their right to directly access to funding for research. Key aspects are: (i) the promotion of cooperation between the different scientific fields; (ii) a multidisciplinary approach in searching funds (from Government, Regions, national authorities, international authorities, European Union, enterprises). The Department of Engineering supports and verifies the quality of the research carried out with the aim of gaining scientific relevance at the national and international level and to cooperate in research and educational activities. The Department of Engineering of the University of Sannio has been recognized among the 180 Departments of Excellence of Italian universities. This recognition offered the opportunity to bring additional funds not only for the strengthening of the research infrastructure but also for the improvement of classrooms and teaching laboratories. Inside the Department of Engineering is operative the Laboratory of Signal and Measurement Information Processing (LESIM). LESIM is devoted to the design and implementation of UAVs hardware and software. In particular, LESIM has competences on; signal processing, mobile platform based on UAV, image processing, remote measurement, 3D reconstruction, structure from motion, sensors for UAV, electronic instrumentation for UAV, electronics hardware design, embedded systems programming, measurement uncertainty, safety characterization of UAVs.

The **University of Cassino and Southern Lazio** (UNICAS) is organized in 5 Departments (Economics and Law; Civil and Mechanical Engineering; Electrical and Information Engineering; Human Arts and Philosophy; Human Science, Societies and Health) providing 14 BSc, 18 MSc and 1 dual degree, 4 MSc in English, and 5 PhD programs to about enrol 10,000 students.

Within the University of Cassino and Southern Lazio, the **Department of Civil and Mechanical Engineering** (DICEM) has the mission is to promote scientific research in all its forms and ensure the dissemination of relevant knowledges and technologies, pursuing excellence in research and teaching, activating interdisciplinary synergies. The scientific fields of reference are mechanical engineering, management, civil and environmental engineering, moreover they deal with basic subjects like physics and chemistry. The DICEM also aims at qualified employment, for its graduates and employees. Further, it ensures the coordination and development of projects of excellence at national and international level. Collaborations with both administrations and public and private companies are intended to promote high-level education and the territory development. The DICEM consists of 53 members, distributed across 23 Scientific-Disciplinary Sectors (SSD) and 12 laboratories.

As part of the University of Cassino and Southern Lazio, DICEM pursues the following specific objectives: continuous improvement in its research services, guaranteeing effectiveness, efficiency, and satisfaction of all interested parties; the technology transfer towards the territory, also by encouraging constitution of university start-ups and spin-offs. Degree Courses: Civil and Environmental Engineering; Industrial Engineering (Cassino and Frosinone). Masters in Civil Engineering; Environmental and Territorial Engineering; Management Engineering (Frosinone); Mechanical Engineering; Mechanical Engineering (in English). Within the DICEM, the Laboratory of Robotics and Mechatronics develops theoretical and experimental methods for the analysis of mechanical behaviour, synthesis and functional design of mechanical machines and systems through the study of kinematics, statics, linear and non-linear dynamics, interactions with the environment and between material surfaces, automation control and identification. The typology of the mechanical systems considered is quite general: driving and operating machines, mechanical devices, mechanisms, transmissions and drives, automatic machines and robots, vehicles, transport and lifting systems, energy production systems, biomechanical systems, micro / nano components and systems.

University of  
Cassino and  
Southern Lazio  
Italy



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University of  
Žilina  
Slovakia

**University of Žilina (UNIZA)** belongs to one of the leading educational and scientific institutions in Slovakia. The current university is no longer focused only on transport and communications. It has seven faculties (the Faculty of Operation and Economics of Transport and Communications, the Faculty of Civil Engineering, the Faculty of Mechanical Engineering, the Faculty of Electrical Engineering, Faculty of Management Science and Informatics, the Faculty of Security Engineering, the Faculty of Humanities). The university also has the following workplaces: the Institute of High Mountain Biology, the Institute of Physical Education, the Institute of Forensic Research and Education, the Institute of Information and Communication Technologies, the Institute of Continuing education, CETRA – Centre for Transport Research, the Institute of Competitiveness and Innovations and the Aviation Training and Education Centre.

Wojskowa  
Akademia  
Techniczna Im  
Jaroslawa  
Dabrowskiego  
(Military  
University of  
Technology)  
Poland

Founded in 1951, the **Military University of Technology (MUT)** in Warsaw, Poland is one of the largest scientific and technological universities and a leading research centre in Poland.

In the academic year 2018/19, over eight thousand civilian and military students have studied first-cycle studies (engineering and bachelor's degree), second cycle studies (master's degree), and third-cycle studies (doctoral degree). Courses at MUT are taught by highly qualified academic staff, composed of over 800 teachers, including 89 professors, 124 habilitated doctors and 470 doctors.

The level and opportunities of studies at the MUT are addressed not only to Polish candidates but also for foreign students. MUT, as a recognized and highly reputable polytechnic university, cooperates with numerous universities, institutions, and research centres in Poland and abroad.

MUT is also an important research centre in Poland, encompassing comprehensive research, implementation, and modernization of technologies, chemistry, physics, economics, and military applications. The construction of the first Polish laser and one of the first computers in the country were developed by scientists at MUT. The University also cooperates with institutes from over 20 countries, including Great Britain, France, Germany, Slovakia, the Czech Republic, Russia, Ukraine, Japan, South Korea, and the USA. Much of the intellectual potential of MUT is involved in solving technical problems for the benefit of the national economy and is widely used in environmental protection, medicine, and industry.

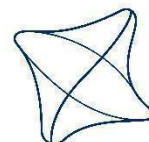
The achievements of MUT in research and scientific activity are confirmed by prestigious state and foreign awards, prizes, and awards from the Ministry of Science, awards from the Polish Academy of Sciences, and more than 1,000 patents and protection rights, including 60 issued by foreign governments. The results of MUT research, presented at many national and foreign exhibitions, verified by international competition, have gained recognition in the world, and are awarded medals and other prestigious awards.

The Robotics and Automation Laboratory enables research in robotics and automation, system integration and creation of control system applications for industrial and military technology. MUT is also a PART 147 organisation, a comprehensive training centre delivering professional PART-66 training for civilian aircraft maintenance personnel. It has just introduced a field of study: "Unmanned Systems Engineering" with two specialities: "Robots and Autonomous Vehicles Designing" and "Unmanned Aerial Vehicles Engineering". It continuously updates a curriculum of the traditional "Aeronautics and Astronautics" field of study inserting UAV knowledge and skills. This field of study has been provided at MUT for above 50 years. Additionally, it provides an annual internship on Aerospace Technology in English targeted at military and civilian foreign students.



**SAPIENZA**  
UNIVERSITÀ DI ROMA

**UNIVERSIAPOLIS**  
Université Internationale d'Agadir  
الجامعة الدولية لأكادير



**UNIVERSITY  
OF ŽILINA**



**Military  
University  
of Technology**





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UNIVERSITÀ  
DEGLI STUDI  
DEL  
SANNIO  
Benevento



University  
of Cassino

## ABOUT THE SCIENCE FOR PEACE AND SECURITY (SPS) PROGRAMME

The NATO Science for Peace and Security (SPS) Programme has been contributing to the core goals of the Alliance for more than six decades. It is one of the largest and most important NATO partnership programmes addressing 21<sup>st</sup> century security challenges, particularly cyber defence, advanced technologies, counter-terrorism, energy security, and defence against chemical, biological, radiological and nuclear agents. As part of NATO's Emerging Security Challenges (ESC) Division, the SPS Programme promotes practical scientific cooperation and capacity- building between researchers, experts and officials from NATO and partner countries. By supporting security- relevant activities in the form of grants for multi-year projects, advanced research workshops, advanced training courses, and advanced study institutes, SPS fosters the creation and expansion of networks of international experts, the sharing of best practices, and the exchange of expertise and know-how among scientific communities in NATO and partner countries.

The Programme involves partners across all of NATO's partnership frameworks (including the Partnership for Peace, the Mediterranean Dialogue, the Istanbul Cooperation Initiatives and cooperations with partners across the globe), through engagements with approximately 2000 experts every year. The Programme also invests in the development of the next generations of researchers, by actively supporting the participation and training of young scientists in its activities. As a testament to the scientific excellence supported by SPS, 21 Nobel Laureates have been involved in its activities since its creation.

The NATO Science for Peace and Security Programme also provides the Alliance with separate, non-military communication channels by bringing together experts from NATO and partner countries, often in situations or regions where other forms of dialogue more focused on defence and security are difficult to establish. Accordingly, the Programme enables NATO to become involved in such regions, often serving as the first concrete link between NATO and new partners, based on partners' request for cooperation.

## CONTACTS

Please visit our website: [www.nato.int/science](http://www.nato.int/science)

Follow us: Twitter at @NATO\_SPS

About the SPS Programme: [sps.info@hq.nato.int](mailto:sps.info@hq.nato.int)



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