

Participating Institutions

The Department of Information Engineering (DINFO), University of Florence, Italy



UNIVERSITÀ
DEGLI STUDI
FIRENZE
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DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

DINFO is one of the 24 departments of the University of Florence, also known as the reference Department for ICT (Information and Communications Technology). It carries out advanced research in control systems, computer science and engineering, electronics systems, electromagnetism, telecommunications, operation research, bioengineering and electrical engineering.

O.Ya.Usikov Institute for Radiophysics and Electronics of the National Academy of Sciences of Ukraine (IRE NASU)



Since its establishment in 1995, the Institute has gained status as a widely-known scientific center, whose achievements determine the level of the national science in radio physics, vacuum electronics, quasi-optics, microwave studies in solid-state physics and biophysics, radio wave propagation, remote sensing of Earth from airborne and space borne platforms, etc.

Jordan University of Science and Technology (JUST)



JUST is a distinguished academic and research institution, dedicated to providing students with an engaging learning environment and a supportive campus culture. JUST offers 143 undergraduate and graduate (MSc and PhD) degrees through its fifteen faculties and institutes.

Franklin & Marshall College, Lancaster, USA



Franklin & Marshall College is a residential college dedicated to excellence in undergraduate liberal education. Its aims are to inspire in young people of high promise and diverse backgrounds a genuine and enduring love for learning, to teach them to read, write, and think critically, to instill in them the capacity for both independent and collaborative action, and to educate them to explore and understand the natural, social and cultural worlds in which they live.



The NATO Science for Peace
and Security Programme

The **NATO Science for Peace and Security (SPS) Programme** is an integral part of the NATO Emerging Security Challenges (ESC) Division. The SPS Programme develops and implements practical cooperation and enhances dialogue between NATO nations and Partner countries through capacity-building and security-related civil science, technology and innovation. All SPS activities contribute towards the Alliance's Strategic Objectives, have a clear link to security and respond to at least one of the SPS Key Priorities.

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Emerging Security
Challenges Division



Multi-Sensor Cooperative Robots for Shallow Buried Explosive Threat Detection - DEMINING ROBOTS

Science for Peace and Security (SPS) Programme

Goal

The main goal of the 'Demining Robots' project is to demonstrate the feasibility of a safe landmine and IED detection system by using a team of cooperative robotic vehicles, each carrying specialized sensors (Ground Penetrating Radar, Optoelectronic, Metal Detector, Holographic Radar). This novel approach allows the collection of multiparametric data.

This NATO SPS Multi-Year Project builds upon the previous SPS project '*Holographic and Impulse Subsurface Radar for Landmine and IED Detection (U-GO 1st)*', which developed a remotely operable, multi-sensor, robotic device for the detection of land mines, unexploded ordnances (UXOs), and improvised explosive devices (IEDs).

How does it work?

- A team of robots operates in sequence for the detection, multi-data imaging, and classification (e.g. landmine vs harmless clutter) by a remote operator of a potential threat.
- Potential threats are then digitally mapped in a geo-referenced coordinate system, and to the appropriate local team or authority for elimination.



Deliverables

There are several scientific and technological deliverables envisaged by this project:

- Technical study of the best robotic hardware to use in various terrain/soil conditions.
- Optimization of MD and GPR operating parameters and data fusion for best ROC performance in discriminating explosive devices from clutter.
- Optimization of the end-to-end process of the investigation in the field.
- Robotic platform architectural design.
- Real time GPR processing for alarm generation (object detection and position).
- Design and develop tripwire detection systems.
- Development of Holographic Subsurface Radar (HSR) for generating 3D image and integration with 3D optoelectronic scanner data for robust interpretation.
- Refinement of high-precision (sub-centimeter) shared positioning for cooperating robots.
- 3D Radar imaging system and 3D optoelectronic scanner data fusion by using a large database.
- Test field on landmine simulants and clutter followed by data acquisition and analysis of ROC curves.
- Final assessment of added value of using a robotic platform in demining operations.

Impact

The 'Demining Robots' project will change the approach to detecting landmines in post-war zones, avoiding direct human-to-mine contact until the threat removal stage, and ultimately introducing a safer demining procedure.

The design approach is based on the new paradigm of Industry 4.0 that allows flexibility to implement a new cyber-physical system, reproducible everywhere and expandable with different sensors and actuators.

- All robots securely share the data in real time with remote terminals and portable devices. Shared data is used to generate a data fusion display to classify explosive threats. The data integration of two different ground penetrating radar (GPR) types is a key point, because the multiparametric imaging of shallow buried objects can improve classification of threats by the operator.
- One robot is equipped with an optoelectronic sensor and suitable image processing software for tripwire and obstacle detection.
- A team of specialized robots acts in cooperation to conduct detection, classification and mapping procedures for shallow threats.

The team of three robots is designed to be agile, lightweight, and optimized for specific tasks required by the minefield characteristics.

