



PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 40th cycle

Research Area n. 1 - Computer Science and Engineering

PNRR 629 TDA Research Field: **DIGITAL TECHNOLOGIES FOR EMERGENCY
MANAGEMENT**

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

Motivation and objectives of the research in this field

Emergency response has become a vital function of the national and European society. Climate change, natural and human-provoked disasters and transport incidents are claiming a severe toll of human lives throughout Europe. The proposed research responds to the challenges facing the Pas with digital technologies enabling a more effective management to the insurgence of emergency events. It empowers emergency management with the novel concept of Emergency Digital Twin (EDT), a digital representation of the emergency scenario, of its physical assets, processes and actors that offers PAs and emergency management operators a solution for last-km emergency management. The proposed research brings a breakthrough in first-responder practice by delivering: 1) novel AI/CV algorithms for autonomous collection and fusion of multi-sensorial data from sensors mounted on drones that can navigate also in prohibitive conditions (in tunnels and occluded environments and in low connectivity environments). 2) Novel AI/CV algorithms for merging UAV images and 3D DEMs to reconstruct the status of the emergency scenario and help detect search and rescue targets and scenario changes. 3) Advanced data exchange methods coping adapted to the lack of connectivity and positioning services. 4) Innovative



	<p>scenario monitoring and prediction for estimating the risk of operators and the evolution of threats.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>Time efficiency is critical in SAR missions to save lives. UAVs with RGB and thermal cameras can be used to scan large areas and collect video sequences. Quickly scanning UAV images is a challenge because targets are visible from a top-down perspective, which makes their appearance different from that in large CV datasets of standard object detection models . Targets might appear very small depending on resolution and flight altitude and their detection is hampered by occlusions (e.g., by smoke and trees). Simple processing techniques leverage color information to detect people and other relevant objects (e.g. clothes or backpacks). Such generic approach generates too many false alarms that slow down the manual inspection. Some proposals implement detectors specifically trained to identify human bodies in SAR flight videos but are not robust to occlusions or unnatural human poses and do not spot partial clues of human presence. Some works reduce the occlusion of the tree canopy by combining images with different perspectives but require precise pose estimation, which is not always available in harsh conditions, and high computational power to integrate images.</p> <p>The proposed research will deploy innovative object detection algorithms executable on resource-constrained drones for real-time operations in complex scenarios, able to operate in presence of occlusions and with limited connectivity and positioning services. This will be pursued by leveraging visual detection techniques that can be pre-trained on generic wilderness areas and fine-tuned on data acquired during the SAR operation. Images are post-processed by detectors tailored to relevant classes, such as standing or lying people, built using state-of-the-art models trained on ad-hoc drone-acquired datasets. Accuracy of solutions will be maximized by designing training procedures for object detection networks that are specific for wild environments, by processing multiple UAV images of the same area acquired from different points of view, to counteract occlusions from smoke or trees and by applying de-hazing techniques to “see</p>



	through smoke” .
Educational objectives	<p>The educational objectives include the development of expertise and skills on:</p> <ul style="list-style-type: none"> - advanced computer vision (CV) skills applied to UAV and remote sensing images - optimization of deep learning based CV techniques for execution on board unmanned vehicles - multimodal data fusion for target detection and scenario reconstruction and monitoring - autonomous unmanned vehicles mission planning and control algorithms and techniques - analysis of organizational processes of PAs and first responders for the integration of digital technologies in the existing operational practices - innovative training methods for operators of the PA to enable the transition from current practices to digitally-powered AI-CV enabled operations
Job opportunities	<p>The doctor will deploy the acquired skills in the PA and in the industry. Target employers are the environment and emergency management agencies of the PA and the data-hungry industries such as the enterprises servicing the Earth Observation, agriculture, construction and logistics sectors.</p>
Composition of the research group	<p>2 Full Professors 2 Associated Professors 3 Assistant Professors 3 PhD Students</p>
Name of the research directors	Piero Fraternali

Contacts
piero.fraternali@polimi.it - https://fraternali.faculty.polimi.it/

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad



Amount monthly	700.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Agenzia Regionale Emergenza Urgenza (AREU)
By number of months at the company	12
Institution or company where the candidate will spend the period abroad (name and brief description)	Istituto Dalle Molle di Studi su Intelligenza Artificiale (IDSIA USI-SUPSI)
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p>EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student.</p> <p>TEACHING ASSISTANTSHIP: availability of funding in recognition of supporting teaching activities by the PhD student. There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.</p> <p>COMPUTER AVAILABILITY: 1st year: Yes 2nd year: Yes 3rd year: Yes</p> <p>CUP: D43C24001140001</p>