



## ΕΜΠ - ΣΗΜΜΥ INTELLIGENT ROBOTICS AND AUTOMATION LAB

### ΑΝΑΚΟΙΝΩΣΗ

Προκηρύχθηκαν νέες θέσεις Υποψηφίων Διδασκτόρων της ΣΗΜΜΥ, με έναρξη το Ακαδ. Έτος 2022-2023, σε θέματα που άπτονται ερευνητικών αντικειμένων του Εργαστηρίου Ρομποτικής της Σχολής (<https://robotics.ntua.gr/>).

<https://www.ece.ntua.gr/gr/announcement/1197>

Τα προτεινόμενα θέματα Διδακτορικής διατριβής προς εκπόνηση στο Εργαστήριο Ρομποτικής της ΣΗΜΜΥ είναι τα ακόλουθα:

- 1) Αυτόνομη πλοήγηση και σχεδιασμός δράσης κινούμενων ρομπότ (*Autonomous mobile robot navigation and action planning*).
- 2) Ρομποτική εκμάθηση δεξιοτήτων και συνεργασία ανθρώπου-ρομπότ (*Robot skill learning and human-robot collaboration*).
- 3) Όραση Υπολογιστών και Μηχανική Μάθηση σε Ρομποτική (ή σε Πολυτροπικά – Πολυαισθητηριακά Περιβάλλοντα) - *Computer Vision and Machine Learning in Robotics (or in Multimodal-Multisensory Environments)*.
- 4) Θεωρητικές Μέθοδοι και Αλγόριθμοι για Μηχανική Μάθηση (*Theoretical Methods and Algorithms for Machine Learning*).

**Για τα θέματα αυτά υπάρχει η δυνατότητα χρηματοδότησης μέσω ερευνητικών προγραμμάτων, όπως:**

A) Στο έργο: "**Ένοποιημένο Ρομποτικό Σύστημα Αυτόνομης Επιθεώρησης και Διάγνωσης Βλαβών σε ΚΥΤ και Υποσταθμούς (ΕΝΟΡΑΣΗ)**", στο πλαίσιο της Δράσης ΕΡΕΥΝΩ-ΔΗΜΙΟΥΡΓΩ-ΚΑΙΝΟΤΟΜΩ του Ταμείου Ανάκαμψης και Ανθεκτικότητας με τη χρηματοδότηση της Ευρωπαϊκής Ένωσης (NextGenerationEU). Στο έργο αυτό θα μελετηθούν μεταξύ άλλων και αλγόριθμοι outdoor 3D SLAM με σύμμιξη αισθητήρων όπως 3D LiDAR, Stereo vision, GPS, IMU, κ.α. Θα μελετηθούν επίσης αλγόριθμοι vision-based perception-aware path planning and motion planning for autonomous outdoor navigation με εφαρμογές σε robotic inspection και robotic exploration.

**Abstract:** The proper functioning of electrical power substation (PS) is vital for the uninterrupted distribution of electrical power to the entire spectrum of consumers in Greece. Unpredictable faults of electrical components or defects due to the effect of fast transients result in system failure and subsequently in the interruption of electrical power supply and the blackout of entire districts of the country. There is a consensus among inspection experts of electrical equipment that the occurrence of these faults would be minimised if inspection was condition-based and not time-based. However, condition-based monitoring requires cost-effective technology that enables the systematic monitoring of equipment and automatic processing of the inspection data in order to achieve early fault diagnosis. Monitoring the spatial distribution of the temperature of electrical components the preferred technique for monitoring the condition. Currently, a frequent condition-based monitoring is not feasible for the Greek Independent Power Transmission Operator due to lack of personnel and lack of available technology. Hence, for the condition-based inspection it is required to introduce new advanced technology that enables automated inspection and maintenance of electrical equipment. It should be mentioned that the installation of static cameras (optical/thermal) is not an option for the scale of an electrical substation due to its large size and due to the required installation time.

B) Στο ευρωπαϊκό έργο "**PILLAR-Robots- Purposeful Intrinsically motivated Lifelong Learning Autonomous Robots**", της Δράσης "Horizon Europe: HORIZON-CL4-2021-DIGITAL-EMERGING-01-1".

**Abstract:** PILLAR-Robots aims at developing a new generation of robots endowed with a higher level of autonomy, that are able to determine their own goals and establish their own strategies, creatively building on the experience acquired during their lifetime to fulfil the desires of their human designers/users in real-life application use-cases brought to TRL5. To this end, the project will operationalize the concept of Purpose, drawn from the cognitive sciences, to increase the autonomy and domain independence of robots during autonomous learning and, at the same time, to lead them to acquire knowledge and skills that are actually relevant for operating in target real applications. In particular, the project will develop algorithms for the acquisition of purpose by the robot, ways to bias the perceptual, motivational and decision systems of the robots' cognitive architectures towards purposes, and strategies for learning representations, skills and models that allow the execution of purpose-related deliberative and reactive decision processes. Given the aim of reaching TRL5, PILLAR-Robots will implement and validate demonstrators of purposeful lifelong open-ended autonomy using the resulting Purposeful Intrinsically Motivated Cognitive Architecture within three different application fields characterized by different types and levels of variability: Agri-food, Edutainment, and unstructured Industrial/retail. PILLAR-Robots will perform a complete evaluation of the possibilities and impacts of purposeful lifelong open-ended autonomy in these realms from an operational perspective, but also from a market-oriented (with significant productivity gains) and societal (socio-economic, ethical and regulatory) perspective. Engagement of industry and SME players is also expected in order to prepare the ground for further large-scale demonstration.

Γ) Στο έργο: “**TROGEMAL: Tropical Geometry and Machine Learning**”, χρηματοδοτούμενο από το Ελληνικό Ίδρυμα Έρευνας και Καινοτομίας (ΕΛ.ΙΔ.Ε.Κ.). Περισσότερες πληροφορίες: [http://robotics.ntua.gr/wp-content/uploads/sites/2/TROGEMAL\\_ResearchPositions\\_announce\\_2022\\_v4.pdf](http://robotics.ntua.gr/wp-content/uploads/sites/2/TROGEMAL_ResearchPositions_announce_2022_v4.pdf)

**Abstract:** Tropical geometry is a relatively recent field in mathematics and computer science that combines elements of algebraic geometry and polyhedral geometry. The scalar arithmetic of its analytic part pre-existed in the form of max-plus and its dual min-plus semiring arithmetic used in finite automata, convex analysis, nonlinear image processing, nonlinear control, and idempotent mathematics. Tropical geometry has recently emerged in the analysis and extension of several classes of problems and systems in both classical machine learning and deep learning. Three such areas include Neural Networks-NNs (both of the multilayer perceptron type and deep NNs), Piecewise-Linear (PWL) regression for data fitting and surface approximation, and Inference algorithms on probabilistic graphical models. The grand vision of TROGEMAL is to greatly advance the theoretical analysis of machine learning systems and algorithms by using and improving tools from tropical geometry and max-plus algebra, as well as discover new algorithms in key areas, including (classic and deep) neural nets, graphical models and nonlinear regression, and extend all the above by advancing a generalized max-\* algebra coupled with learning through novel systems evolving over nonlinear vector spaces. We group the proposed research in four main objectives: 1) Tropical Regression, 2) Tropical Geometry of Neural Networks, 3) Tropical Geometry of Graphical Models and Inference Algorithms and 4) Generalized Tropical Geometry and Learning on Weighted Lattices. Based on the PI's and his team's rich previous experience, TROGEMAL will pursue scientific excellence in researching the above research objectives and aspires to make substantial advances with a strong impact in several theoretical and algorithmic areas at the intersection of machine learning and tropical geometry and algebra. Applications areas include computer vision, NLP, and data science.

Δ) Στα ανωτέρω θέματα, υπάρχει επίσης η δυνατότητα χρηματοδότησης της διδακτορικής διατριβής μέσω υποτροφίας ΕΛΚΕ Υ.Δρ. της Σχολής.

Στο πλαίσιο της διδακτορικής έρευνας προβλέπονται ερευνητικές επισκέψεις σε συνεργαζόμενους πανεπιστημιακούς φορείς ή ερευνητικά κέντρα του εξωτερικού, όπως: TUM (Μόναχο, Γερμανία), KIT (Karlsruhe, Γερμανία), IIT (Γένοβα, Ιταλία), ISIR (CNRS - Sorbonne Université, Παρίσι, Γαλλία), UPenn (USA), USC (USA), κ.α.

Για τα θέματα 1) και 2) οι ενδιαφερόμενοι καλούνται να επικοινωνήσουν με τον Αν. Καθ. Κων/νο Τζαφέστα (email: [ktzaf@cs.ntua.gr](mailto:ktzaf@cs.ntua.gr)).

Για τα θέματα 3) και 4) οι ενδιαφερόμενοι καλούνται να επικοινωνήσουν με τον Καθ. Πέτρο Μαραγκό (email: [maragos@cs.ntua.gr](mailto:maragos@cs.ntua.gr))