Sorbonne Center of Artificial Intelligence opens a Ph.D student position

in Artificial Intelligence Field

In the context of **INDUSTRIAL CHAIR of EXCELLENCE**, Sorbonne Center of AI opens a Ph.D. position at SCAI Abu Dhabi in collaboration with Thales, Aveillant UK, Cambridge University and Sorbonne University.

Related to the field of **Artificial Intelligence**, the Ph.D research will include the following topics: Intelligent Agents and Multiagent Systems, Machine Learning and Cognitive Radars. The thesis title is:

Hybrid AI for the design of intelligent radars

Joint recognition and tracking of drones in complex environments

Ph.D position specifications

- Selected applicant for this position will be full time student seeking a Ph.D. in Artificial Intelligence. The admission is contingent upon approval form the Sorbonne University, Paris. The diploma will also be granted from the Sorbonne University, Paris.
- This position is intended for applicants from **EU or the United Kingdom**, holding a master's degree or equivalent, or an engineering degree conferring the master's degree.
- The candidate must be mobile as the work of the thesis will take place in 3 locations: Sorbonne University - Abu Dhabi, Sorbonne University - Paris and Cambridge / Aveillant UK.
- The Ph.D position is fully funded including tuition exemption, stipend and support for travelling.
- The Ph.D position should be started as soon as possible and not later the **mid of September 2021**.
- The **deadline to apply is 15th of May 2021**

Knowledge in the following areas is required:

- Autonomous Agents and Multi-agent systems: modeling, design and evaluation.
- Good background in AI technics: Machine Learning: Linear regression, discriminant functions, supervised and unsupervised learning, deep learning, classification, pattern recognition, reinforcement learning, and neural networks.
- knowledge of radars and signal processing is an advantage.

Required technical skills:

- Ability to communicate effectively in English, both orally and in writing.

- Strong skills in programming languages such as Python, R, MATLAB, Java, and C++. Skills in Pytorch, TensorFlow, and Multi-agent programming are a plus.
- Strong background in mathematical modeling and computer simulations.
- Ability to develop and deliver presentations.
- Ability to work effectively with a multiple diverse community.
- Strong commitment and perseverance to achieve assigned tasks and meet the deadlines.

Admission requirements:

- Minimum score of 550 in TOEFL, 6.5 in IELTS, or their equivalent.
- Minimum CGPA of 3.5 in the Master degree (or its equivalent). Major should be in Computer Science, Computer engineering, Mathematics or any closely related field. Thesis option in the Master is preferred.
- Minimum CGPA of 3.0 in the Bachelor degree (or its equivalent). Major should be in Computer Science, Computer engineering, Mathematics or any closely related field.
- Three recommendation letters from academic faculty or profession superiors.

Interested applicants may send their CV to:

Prof. Amal El Fallah Seghrouchni - Holder of the chair of excellence
Sorbonne University - LIP6 – CNRS – SCAI and UM6P
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ONLY SHORT-LISTED APPLICANTS WILL BE CONTACTED.

PhD Subject Description

In the quest to build autonomous intelligent systems able to form hypotheses, make decisions, learn from data, and adapt their behavior to changes in their environment, several large-scale organizations have begun to align around a concept known as the "Cognitive Era" [1].

To design autonomous intelligent radars, capable of intelligent surveillance capability in complex environments as those of Thales missions, several cognitive functions are necessary, such as the perception and the representation of the environment (including other radars and threats), reasoning about knowledge and ongoing actions as well as learning from past experiences. Hybrid AI is then necessary to combine all these functions; in addition, their collaboration within a radar to achieve the sought intelligent surveillance.

The goals addressed in this thesis are the following. First, we are interested in proposing an architecture based on agent paradigm which is able to embed the necessary cognitive functions in hybrid manner; then, to define an orchestration mechanism in order the take benefit from these functions in a cooperative way.

The agent paradigm is particularly recommended as a suitable receptacle for embedded hybrid AI. Indeed, an agent architecture is modular [2] and it is possible to define an interpreter able to build a life cycle and to orchestrate the agent basic building functions. At the agent level, these various functions can collaborate and produce a coherent behavior. When more radars are involved, *e.g* in multi-static scenarios, a multiagent system paradigm [9] offers many tools for cooperation, coordination and collaborative problem solving [12, 2].

Case study: Cognitive Radars

Safety, security and defence operations increasing rely on the use of friendly drones (or UAVs) whilst facing the threat of hostile drones. Of all sensors, radar sensors provide the most assurance in sensing drones, particularly non-cooperative drones such as those that are operated autonomously.

Drones have low radar cross section, fly at low speeds in dense clutter environments and they can be easily confused with natural (for example birds) and manmade targets. This represents a significant problem for their effective detection, tracking and recognition.

Effective tracking aids robust recognition, yet in dense target environments, recognition features are important for effective tracking.

In this study we propose to rely on agent paradigm and to develop AI techniques to jointly solve the problem of recognition and tracking of UAVs and drones, using combinations of AI recognition, AI tracking and AI supervisory agents. The scope of these techniques will be further broadened to encompass measurements from networks of radars, to manage handover between coverage zones and include additional information gathered from radars with different aspects of view or fundamental properties.

This work will be supported by real radar measurements and further measurements could be collected using Aveillant Gamekeeper radars.

AI background:

Suitable AI techniques could be integrated into agents: MCTS (Monte-Carlo Tree Search) and Reinforcement Learning (RL) in continuous spaces, e.g. with unknown Markov Decision process, for Multiple hypotheses tracking & recognition where the agent (i.e. tracker) uses a computationally tractable algorithm to perform the two tasks of estimating the system state (e.g. target kinematics state) which can incorporate the target identity (i.e. recognition) with the inherent present uncertainties and the planning of its action (i.e. in this context this is to optimize its strategies for tuning their parameters with respect to target kinematic and identification) within a Bayesian framework. This can be drawn on the prior work in [1]. Addressing the adaptation of the recognition algorithm (e.g. kernels-based) parameters within this formulation (e.g. based on distribution shifts in a simple of case) can be highly beneficial.

Thesis topics to be addressed include:

- **Topic 1:** Agent and Multiagent architectures and modelling: Multiple agents act as trackers (e.g. address longer time scales comparing with the conventional *sensor-level* trackers, e.g. Kalman or SMC filters, which are often based on first order Markov models) and address tracking inaccuracies arising from uncertain target dynamics, i.e. non-representative Bayesian priors. This can encompass revisiting

the tracker results for a finite duration in the past, similar to smoothers, such that the agents compete to explain previous observations and can adaptively modify their parameters (policies) for future measurements.

- **Topic 2:** The latter formulation can be extended to multiple radar settings by using suitable cooperation mechanisms such as distributed auctions strategies for association of data, negotiation or consensus.

Supervisors & Point of contact

- SORBONNE University – SCAI Paris - Full Professor and Supervisor: Amal El Fallah Seghrouchni
- SORBONNE University – SCAI Abu Dhabi - Professor and co-Supervisor: Raed Abuzitar
- THALES LAS/AVEILLANT Manager Supervisor: Stephen Harman
- THALES LAS/AVEILLANT Technical Supervisor: Bashar Ahmad
- THALES KTD PCC Supervisor: Frédéric Barbaresco
- THALES LAS/DT Point of Contact: Walid Benzarti

Workshare & Planning

The academic work on this PhD will be carried out at SCAI Sorbonne University, whilst technology familiarization, integration and knowledge transfer activities will be offered at Aveillant Ltd in the UK. The suggested plan is given below:

Month 1-3 Technology Familiarization + Literature review on Radar (Aveillant UK)

Month 4-9 Literature review on AI (SCAI Sorbonne)

Month 10-16 Development, formulation & theoretical basis of 'Topic Number 1' (SCAI Sorbonne)

Month 17-23 Development, formulation & theoretical basis of 'Topic Number 2' (SCAI Sorbonne)

Month 24-30 Implementation of selected topics for real time operations on Holographic radar sensing of Drones (SCAI Sorbonne + Aveillant UK + THALES UAE)

Month 31-36 Integration & knowledge transfer, possibility for demonstration if opportunities exist (Aveillant UK) + PhD manuscript preparation

References

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sale or use in derivative works. Copyright © 2017, David L. Poole and Alan K. Mackworth. This book is published by Cambridge University Press.

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