PhD proposal (convention CIFRE), Computer Science

Self-Organized Representations of Dynamical Environments for a Welcoming Task by an Autonomous Robot

1 Institutions and location

CentraleSupélec[1] and Partnering Robotics[2] have started in 2015 a collaboration about bio-inspired artificial intelligence applied to indoor service robotics. Supporting industrial innovation by the funding of Ph.D fellowships in collaboration with academic partners is one of the ANRT[3] actions. In the present CIFRE convention is an opportunity to perform a significant step further in that collaboration. The PhD student will be hosted at the Metz campus of CentraleSupélec and at Cergy in the premises of Partnering Robotics.

1.1 CentraleSupélec

CentraleSupélec is a French institute of research and higher education in engineering sciences. It was established since 2015 as a result of a strategic merger between two leading "grandes écoles" of France: École Centrale Paris and Supélec.

The Metz campus of CentraleSupélec carries out research about cortically-inspired computer science. It also hosts a robotic laboratory called "smartroom[4]". The PhD will be supervised by:

- Hervé Frezza-Buet (HDR in computer science), herve.frezza-buet@centralesupelec.fr

- Jérémy Fix (PhD in computer science), jeremy.fix@centralesupelec.fr

1.2 Partnering Robotics

Whatever the sources interviewed, robotic industries will represent by 2015 a market potential valued at tens billions euros with a growing potential in 2020. Whatever the angle is to address this market through humanoid technology platforms or not, softwares, digital services, etc.., estimated figures are impressive!

Past history shows that the structure of an industry is the result of complex interactions and often random. Our point of view is singular. At Partnering 3.0, we believe that an approach through Innovation Networks can make the difference, and rather than talking about it, we implement, at our pace, our view based on our vision: "share to win" . This vision is different from the paradigm "Win / Win" that do not match with the 21st century context and the changes in the competitive environment. In short, this vision relies on specific strategic levers: Creativity,

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[1] http://www.centralesupelec.fr
[2] http://partnering-robotics.com
[3] http://www.anrt.asso.fr
[4] http://smartroom.metz.supelec.fr

Organizational flexibility, Networks 2.0, Business Model, R&D technology platforms and targeted uses.

At Partnering 3.0, we are looking to develop solutions or alternatives to systems that are not optimal or emerging. In this context, robotic industries are particularly fertile. Our goal at Partnering 3.0 is to create new robotics usages for "cultural public places", "home with digital converging services" and "the enterprise 2.0". These usages will rely on new platforms modules and software.

Partnering 3.0 relies on a team that has an extensive professional experience in the areas of information technologies, electronics, web and digital printing. Our experts have occupied important jobs in firms such as Intel, Canon, Alcatel or 3Com or start-ups such as Perle Systems or IQ Technologies. We have different profiles: scientists, engineers, business developers, and sales.

Our Competence has been gained on the field with convincing results in operational and management functions in the domains of Strategy, Business Development, Sales, Marketing, Product, men and team coaching, R& D or Key Accounts. Our qualities have just been derived in the midst of large international teams or within small "task force": we have learnt in situation highly exposed to strong competition and to a permanent control of stress.

These experiences have led us to work with different categories of customers (suppliers of utilities, manufacturers, groups of research workers, integrators, key account, institutions, medium and small scale industries, retailers, wholesale dealers, mass market). This has helped to build up during several long years our know-how in the development of lasting relations with our customers.

The PhD will be supervised by:

- Ramesh Caussy, head of Partnering 3.0, ramesh.caussy@partnering.fr

2   Research topic

One challenging question in artificial intelligence is the representationalism (Haselager et al., 2003; Warren, 2006): "Do a machine need an explicit internal representation of what it should handle?". Many neuro-inspired approaches aim at providing a negative answer, since the distributed activity of a whole neural network can be used by a machine in lieu of a representation. The proposed PhD addresses this issue with a strong focus on dynamic environments. The idea is to set up a neural network that can provide an implicit and compact representation of the configuration of a crowd of people surrounding a robot. The configuration, here, has to be understood as the positions of the people as well as its dynamics (e.g. is the robot surrounded by still people or is it static in a flow of people all rushing in the same direction?). Clearly, the compactness of the representation will be driven by the task the robot must perform which might require to select only part of the available visual information. The idea is to rely on previous work at CentraleSupélec on dynamical and recurrent self organizing systems (Baheux et al., 2014; Khouzam and Frezza-Buet, 2013; Fix, 2014), involving both temporal and multi-modal self-organization. Handling the complexity of this kind of self-organizing systems is one challenging expected contribution of the PhD to computer science.

The application to the industrial robotic platform Diya One (see figure 1) offers another challenging aspect of the research. Indeed, the goal is to use the implicit dynamic representations for building up a smart, efficient and acceptable welcoming behavior. Partnering would like to add such social services to its robotic platform in order to widen the field of application toward human-robot interactions.

3   Expected skills

The PhD student is expected to be curious about image processing and machine learning, opened to unconventional bio-inspired computing. Programming skills are also of primary interest (`C++`, `Linux`) since experimentation on the Diya One platform is targeted.

Figure 1: The DIYA ONE robot by Partnering Robotics.

References

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Haselager, W. F. G., Bongers, R. M., and van Rooij, I. (2003). Cognitive science, representations and dynamical systems theory. In Tschacher, W. and Dauwalder, J.-P., editors, *The dynamical systems approach to cognition: Concepts and empirical paradigms based on self-organization, embodiment, and coordination Dynamics.*, volume 10 of *Studies of Nonlinear Phenomena in Life Science*, pages 229–242. World Scientific.

Khouzam, B. and Frezza-Buet, H. (2013). Distributed recurrent self-organization for tracking the state of non-stationary partially observable dynamical systems. *Biologically Inspired Cognitive Architectures*, 3:87–104.

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