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INTERNATIONAL JOURNAL OF
ADVANCED ROBOTIC SYSTEMS
CELEBRATING 10 YEARS

Dr. Claude F. Touzet: cognitive science and artificial neural networks

Claude F. Touzet is an associate-professor at the University of Provence, Marseilles, specialized in Cognitives Sciences. He is a recognized specialist in artificial neural networks and their applications to the industry. Dr. Touzet authored two research papers published in the International Journal of Advanced Robotic Systems (IJARS), "Distributed Lazy Q-Learning for Cooperative Mobile Robots" (2004), and "Modeling and Simulation of Elementary Robot Behaviors Using Associative Memories" (2006).

IJARS's team: 10 years ago we had the chance to publish in the International Journal of Advanced Robotic Systems an interview with you concerning your interest in robotics and your research in robot control. Has your focus in robotics shifted to new areas of interest?

Dr. Touzet: It may seen that my areas of interest shifted towards neurosciences – after all, I belong to a neurosciences lab since 2001, but it is not the case. I have had the same question in mind for the last 30 years ("who are we?"). I started my research career with 10 years of ANN (Artificial Neural Networks), followed by 10 years of robot learning, after what I undertook the challenge to join a neurosciences team, got acquainted with the human aspects of "my" question, and put my modelization and simulation expertise at work in this new domain.

IJARS's team: In the past 10 years since that interview, what do you consider to be the biggest milestones in your research?

Dr. Touzet: In 2006, I wrote a paper in IJARS describing a new programming framework allowing the instantaneous synthesis of a large number of mobile robot

behaviors. I used to think of myself as a learning specialist, but this “milestone” put an end to my “robot learning” career: no trick nor complex learning algorithm was required by this “associative memory programming” – which nevertheless achieves a much better performance. It was like to saw off the branch that you're sitting on.

In return, this upsetting discovery helped me reconsider the idea that cognition was some kind of a side-effect (not searched for by mother Nature), that there was a possibility that a unique organizing/functioning principle would explain all of the human mind. Even today, that idea is considered to be wrong, if only because it was an unsuccessful quest over several decencies. It is not that easy to question dominant ideas – I was lucky to have been personally shaken by a discovery that required complete reassessment of myself.

IJARS's team: You have a multidisciplinary approach applied to your research, using principles of neurobiology in robotics. Thinking of the latest developments in robotics, have we reached the stage when without a multidisciplinary approach it’s not possible to advance from an applied research point of view?

Dr. Touzet: Yes, completely true. To advance, we need imagination, but it is quite difficult to be imaginative when you share the exact same background as everybody else who is working in the field – it is much easier to borrow, and adapt from other domains. Some domains are logical choices, such as neurosciences, cognitive science, psychology – domains that have also a much longer history than robotics, and many times more researchers. However, I am convinced that any domain could be of help.

IJARS's team: Your research in the field of robotics and automation impacts your research in the field of neurobiology and vice versa. How much has your research in robotics helped you in your work towards the prevention of cognitive aging and within the cognitive rehabilitation area?

Dr. Touzet: In 2005, I started a collaboration with Dr. B. Alescio-Lautier, a specialist of human memory and its dysfunctions. Together we developed and patented a method to prevent cognitive aging that received several national awards. A university spin-off company was even founded to distribute this program, with a version targeting the public and another one for the professionals. The user has access to a set of multi-media exercises targeting the various memories and attentional processes. The level of difficulty is adjusted to the cognitive performance of the subject through the use of automatic learning procedures. This is of tremendous importance since the user performance will improve over time, and the level, order, duration of the exercises

must match. Our cognitive training efficiency was demonstrated by several scientific studies targeting various populations (elderly, Alzheimer disease, Mild Cognitive Impairment, cranial trauma, etc.). It would not have been that successful without the "robot learning" part.

IJARS's team: Also, how has your recent research in neuroscience influenced your latest research output in the area of robot learning?

Dr. Touzet: Developing and evaluating softwares dedicated to improve human cognitive abilities has given me a practical knowledge about these not so well-defined concepts (episodic memory, semantic memory, working memory, focused attention, divided attention, planning, inhibition, etc.). Therefore, I was able to reinterpret some of the robot learning properties as representative of human cognition. It was a big improvement because it allowed me to consider – with reasons to do so – human cognition level as a realistic goal for a robot.

IJARS's team: Most of your work within robotics aims at the final goal of contributing to AI advancement. How close are we to developing a conscious robot and what does exactly mean "conscious" when applied to a robotic system?

Dr. Touzet: I believe that today's computing power allows the implementation of a robot with the cognitive capacity of a human. What was missing was the blueprints of such robotic brain – it is the *raison d'être* of my Theory of neural Cognition. Among other thing, this theory states that consciousness is the result of the implication of the language cortical maps. If their activations are strong and precise enough to put words on the events, then we like like as if we are conscious. To make a long argument short, consciousness is an automatic verbalization. No doubt that a robot can be given the same ability – if its learning is very similar to that of a human child. This is the reason why I coined the term "robot-sitting" (derived from "baby-sitting").

IJARS's team: In your recent book published in 2010 on the topic of the Theory of neural Cognition (TnC), you state that we are the result of our interactions with the environment around us and that, among other conclusions, the brain does not process information but it represents it; this gives a whole new meaning to the role of our neural networks and the perception we have of the world. How does this new theory affect your robotics research?

Dr. Touzet: One of the major outbreaks of the TnC is that a "conscious" robot is within our reach. We can even calculate the computing power requirements, the shape and

size requested by such robot, its sensors and effectors equipment, and also have specifications relatively to its education (learning). I have done some speculations on that matter in the companion paper of this interview (cf. this journal).

IJARS's team: Robotics and the development and advancement of robotic systems are very much tied to financial support by both various industries and institutions with an interest in robotics; how much does that influence researchers in their research?

Dr. Touzet: Financial support is crucial, or – at least – it is believed to be so. In fact, when I compare the costs involved in neurosciences studies, and those in robotics, I can say that robotics is not a costly domain. In the recent past, EU decided to make a major research effort of 1.2 billion Euro (over 10 years) in a specific domain. Among many candidates, the two nominees for the final competition where the "Human Brain Project" and the "Robot Companion Project". To be the recipients of such amount of founding, one has to demonstrate that numerous industries and institutions support, and will benefit from the project. The interesting part of this EU Flagship project is that the management (including spending) is handed to the scientists responsible of the project. So, for about 10 years, the research will have a direct access to the necessary funding – instead of having to lobby various administrative and political levels. The Robot Companion Project did not make it, but the Human Brain Project is broadening its objectives which now include robotic testbeds – not yet a fusion of both projects, but who knows!

IJARS's team: How do you envision a society where robots with advanced AI are part of our every day life? What is the ultimate scope of AI in point of view?

Dr. Touzet: A cognitive/conscious/intelligent robot could be beneficial in many areas. In my opinion, the title of the "Robot Companion" Project was well chosen. These robots will have a human-like cognition, we will have to consider them as persons. However, the main difference will be that you can copy/paste a robot brain...

I don't think that this is the ultimate goal of AI. The ultimate goal is – in my opinion – to build a "super" intelligence (which is not the case of the human-like cognitive robot). Having build an intelligent robot, we will certainly have ideas about how to improve on that intelligence. I am not sure that we will be able to understand it. I presume that it will be an "alien intelligence", not very different from any deep space encounters that the astrophysicists are looking for.

IJARS's team: This year IJARS celebrates 10 years of its establishment. We published your paper titled "Distributed Lazy Q-Learning for Cooperative Mobile Robots" in the first issue of the journal. What do you think when you look back at that paper?

Dr. Touzet: If you go with the classical "citation index", then this paper was no blockbuster (36 citations). However, one must not look back at paper relevance using such indicator. The potential impact of any paper has no expiration date, and its importance does not rely on the number of persons who came to know it. A paper may affect the thinking process of just one researcher – even unconsciously – and that could lead to a great success. So, the answer to this question is: we will never know. However, as the author, I can add that this particular research results were used in a Web accelerator software based on the idea that multiple users may cooperate in order to predict Web user behavior (and prefetch pages, which cuts by 2 the waiting time). Today, I know of another company which is using this algorithm to increase the conversion rate (from Web visitors to customers) by predicting who can be converted by which incentive.

IJARS's team: What are your future short term plans or upcoming research projects?

I just finished a 2nd book about the TnC, which tackles questions unanswered in the previous opus, such as the placebo effect, sleep, hypnosis, homeostasis, belief, motivation, etc. My next challenge has already started: writing a 3rd book which exposes the various (Python) programs required by the challenge of building a conscious robot. On a longer timescale, I would like to be part of the adventure of building a real conscious robot. That would be like adding a child to my family.

IJARS's team: Any thoughts you would like to share with us for IJARS's 10th birthday?

Dr. Touzet: Progress, by definition, is not predictable. It is not mainstream thinking. I wish that IJARS and its readers will keep an open mind, refuse *a priori*, and forbid censure. These principles, today exhibited by the journal,must be preserved for the future reader generations.

This interview has been provided as part of many celebratory activities for the International Journal of Advanced Robotic Systems' 10th year anniversary. IJARS's editorial team would like to thank Dr. Claude F. Touzet for taking part to our robotics interview series.

IJARS's team

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