Cognition for Effective Control

Jean-Daniel Dessimoz
HEIG-VD, School of Business and Engineering
HES-SO, Western Switzerland University of Applied Sciences and Arts
Yverdon-les-Bains, Switzerland
Jean-Daniel.Dessimoz@Heig-VD.ch

Abstract

For control, cognition is crucial in many respects. Six of the most significant aspects are summarized below, along with some real-world examples, taken in robotic context.

1. First, control implies the definition of a target state, a more or less elaborate model of what reality is aimed at, as a future goal; for example just a voltage level, the location of a robot, or the vision of a desired, complex, different, and possibly future world.

2. In some cases, a sequence of control actions, appropriately specified, may lead to the desired, goal state. In this case, in addition to the modeling of final stage, some modeling must also be elaborated for all intermediate actions to perform in order to reach there.

3. Actions are first defined in cognitive terms, as pieces of information (messages) of relatively high and abstract content. Then this must usually be expanded into more detailed directives, as a concretization process. For example a motion law will constrain acceleration and speed parameters so as to reach the target location in best conditions; or for more complex situation, some planning, with joint coordination and obstacle avoidance may be mandatory.

4. In general, systems are embedded in reality domains where unpredictable disturbances may occur, or worse, where much is yet unknown. For simpler cases in control, a Boolean estimate of the situation, or possibly a scalar value may prove sufficient to support decisions; and for more complex cases, other cognitive faculties/functionalities are required, such as perception or even exploration, which is an active process to gather information in unknown domains. Here control is classically said to be « closed loop » : actions applied by the control system (CS) onto the system to be controlled (TBCS) are fed backwards to the control system, via measurements and perceptive paths.

5. In closed-loop cases, some critical time properties of CS versus TBCS are required, to allow for success. Moreover, in these cases, and more specifically when controllers make a difference, i.e. in « slower » cases, expertise can further help tuning for best performances. Thus in particular, a sound, cognitive approach may often compensate for otherwise uncompressible reaction times. For example in robot control, instantaneous accelerations and speeds are largely dictated by higher-level controllers, which may consequently lead to so-called a priori components, instead of relying on feedback components essentially resulting from errors.

6. As control systems gain in scope, multiple agents appear and patterns of sociology must develop. This ranges from classical, hierarchical systems, with windows of autonomy at lower levels, to broader, group patterns, where common communication channels and shared cultural references support novel coordinated, collective behaviors, as if ensured by a single, overall meta-agent. From a cognitive perspective, individual thinking and meditation then evolve towards group discussions and deliberation, with the perspective of defining effective subsequent control steps. For example in the Robocup@Home case demonstrated in Singapore, our RH-Y robot group consisted in three major agents (robots) cooperating to serve a human with drink and snacks.

HESSO.HEIG-VD, JDZ, 2015.10.23