Proceedings of the 3rd International Conference on Control, Dynamic Systems, and Robotics (CDSR'16)
Ottawa, Canada – May 9 – 10, 2016
DOI: 10.11159/cdsr16.3

Control Theory Might be Different than You Think It Is

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As an applied discipline, we have a pretty good idea what control theory is. The basic problems -- stabilisability, controllability, output regulation, path planning, some possibly subject to optimality or robustness considerations -- are clearly understandable in the context of a given application. And applied control theory has been very successful in terms of developing methodologies for addressing these problems, especially for linear, but sometimes for nonlinear, systems.

Things get murkier when one wishes to think of control theory as a mathematical discipline. For linear control theory the story is often told and pretty well understood. For nonlinear systems, this is just not so, especially if one makes (as one should) the evolution from nonlinear to geometric control theory. In geometric control theory, one realises, after some thought, that one should think carefully about system representations. More precisely, the realisation one comes to is that many ideas in control theory are not about systems per se, but about systems with specific representations. This leads to a situation where it will be very difficult to understand system properties, because one instead is studying properties of a specific representation.

In this talk, the preceding paragraph will be explained, starting from some fairly tame-sounding problems in the control of mechanical systems, and ending with some difficult problems in functional analysis. Along the way, it will be seen that some widely accepted constructions in control theory could benefit from more thought than is commonly given them.