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Autonomous robotics

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Essay Exercise 5: Attractor Dynamics for vehicle cooperation

This essay exercise is worth triple bonus points. We ask you to read a difficult paper in some detail and to test your understanding by summarizing important points of the paper in your own words. Wrie structured text that a reader who has not read the paper may follow! Use complete sentences (English or German). It is a good idea to use illustrations, which you should explain in text as well. If you want to copy illustrations from the paper, reference them. You may work in teams, but must submit your own version of the essay that is not text-identical (or almost identical) with those of your colleagues. The length of the text should be appropriate to convey the ideas and depends on your choices. But because we are often asked about that: 10 pages may be a reasonable order of magnitude.

The paper Machado et al.: "Attractor dynamics approach to joint transportation by autonomous robots: theory, implementation and validation on the factory floor" *Autonomous Robots* **43**:589610 (2019) [available on the web page] is both a great review of the attractor dynamics approach and an extension that solves a complex problem of coordination between two robot vehicles.

First read the paper as a whole. Some of the detailed mathematical formalization around Eqs 7, 12, 19, 20, 22 do not need to be analyzed, as long as you understand their conceptual meaning on the basis of the relevant figures (e.g. Fig 5 for Equation 7, Figure 6 for Equation 12). You don't need to fully understand section 4.1.4.

Then structure an essay, about key ideas of the paper. The essay is not meant to be a plain summary or re-telling of the paper, but a discussion focussed on specific points outlined here:

1. The attractor dynamics is designed so that vehicle motion satisfies a number of constraints by adding different contributions to the behavioral dynamics. For the dynamics of heading direction, what are different constraints that are being addressed, how are they expressed in terms of heading direction, how are they mapped onto dynamic parameters. You list could refer to each equation that describes a constraint.

2. What are the four main features the authors highlight in their results? Describe in each case the property of the approach emphasized by the authors. You can access the referenced videos at
`https://link.springer.com/article/10.1007%2Fs10514-018-9729-2`.

3. The authors repeatedly point out two specific issues: (1) The need for noise near instabilities; (2) The fact that the actual heading direction is not needed to implement a constraint. Explain these two points referring to the places in the text where these are discussed.