

May 21, 2021

## Essay Exercise 4 Attractor Dynamics for vehicle cooperation

*This is an essay exercise that earns you triple Bonus points. It asks you to read a difficult paper in some detail (task 1) and to prove that you did so with success by summarizing some of the points in your own words (tasks 2, 3, and 4). Write text that a reader who has not read the paper can 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.*

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.

1. 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.
2. The approach addresses a number of constraints, each by adding a contribution to the behavioral dynamics. Focussing on the dynamics of heading direction, make a list of the different constraints that are being addressed, in each case mentioning the behavioral variable, the nature of the constraint, its parameterization by the attractor/repellor location, and the Equation that describes the constraint.
3. Study the results. You can access the videos referred to at <https://link.springer.com/article/10.1007%2Fs10514-018-9729-2>. Make a list of the four main features the authors high-light in their results. For each feature, describe in your own words the high-lighted property of the approach.
4. 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 and refer to the places in the text where these are discussed.