

Final Exam (Version A): PDE-Based Motion Planning for Robots

The conference paper

[1] **MA Belabbas, S Liu:** New method for motion planning for non-holonomic systems using partial differential equations. *2017 American Control Conference (ACC)*, 2017, pp 4189-4194. DOI: <https://doi.org/10.23919/ACC.2017.7963599>

presents the key ideas of a method for computing controls and trajectories of robots from an initial state to a final state. The method could be used for controlling industrial robots, vacuum robots, autonomous vehicles or drones. It relies on advanced mathematical concepts of abstract geometry, but eventually leads to a system of coupled PDEs that can be solved numerically to compute trajectories, which are (nearly) optimal in a certain sense.

Based the approach presented in the above paper [1], develop your own small research question. This could be on an idea you may have for modifying, improving on or extending a certain aspect of the method of Belabbas and Liu. It could also be on another application of their approach that is of interest to you. Apply the methods you have learnt in this course to try and answer your research question. Present your work and your findings in a short paper.

Your paper must include the following:

- A concise title
- An abstract outlining the problem you study, your methods and your results
- An introduction to
 - the topic of motion planning in general, including a brief review of the pertinent literature
 - the particular method for motion planning used here, including an exact specification of the underlying PDE problem
- Results of a benchmark example with which you demonstrate that the method and the implementation you use are working
- Your own study
 - what you investigate and why
 - how you investigate it
 - what results you find
- One or more conclusions that you can draw from your study
- A list of references that were cited in the text

Formatting You may structure and format your paper in a similar fashion to the paper of Belabbas and Liu [1]. You may also use an actual journal template, such as one of the IEEE journals:

<https://template-selector.ieee.org/secure/templateSelector/publicationType>

Page Limit Your paper has a strict upper limit of five pages. A cover page (if any) or the list of references are not included in the page limit. All content exceeding the page limit will be ignored.

Figures Make sure that all your graphs are fully labelled, that they are sufficiently large and of high quality.

References Use a uniform citation style. A citation will be considered complete if it contains the authors' names, the title, details of the journal or publisher, the year of publication and the DOI whenever one is available.

Target Audience Your paper should be accessible to an audience that is literate in numerical methods for PDEs, such as you and your classmates prior to starting research on the topic of this exam. You must provide enough information and supplementary materials for them to be able to understand and reproduce your work.