Abstract: Motion planning for under-actuated systems is one of the most challenging outstanding problem at the intersection of robotics, control engineering and applied mathematics. The difficulty of the problem stems from different issues, prime amongst them are the presence of holonomic and non-holonomic constraints, and the need to avoid obstacles in physical or configuration space. To address these difficulties, many ad-hoc techniques based on artificial intelligence or optimal control have been developed. Due to their “black-box” nature, it is difficult to assess the quality of the control obtained. In this talk, we propose here a novel method for motion planning. The method is a homotopy method: it proceeds by deforming an arbitrary path joining the initial state to a desired final state into an admissible path, that is a path that meets the various constraints of the problem. The method is based on relatively recent developments in geometric analysis. In a nutshell, it consists of encoding the various constraints of the problem in an appropriately-defined inner product which is then used to derive a parabolic partial differential equation whose solution provides the sought homotopy between an arbitrary path and a feasible trajectory for the system to follow. We will present the method in details and apply it to various canonical motion planning examples.

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