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A BRIEF STUDY OF PROPERTY OF LIE BRACKET

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Abstract: In this paper we propose a novel methodology for the analysis of autonomous vehicles seeking the extremum of an arbitrary smooth nonlinear map in the plane. By interpreting the extremum seeking schemes as input-affine systems with periodic excitations and by using the methodology of Lie brackets, we calculate a simplified system which approximates the qualitative behavior of the original one better than existing methods. Global representation and various properties of the rigid body attitude, i.e., SO(3), are investigated in this paper. The representations, Euler-Lagrange equation, and Hamilton's equation on the second bundle of SO(3) are formally given.

Keywords: Quaternions, Controllability, Space vehicles, Position measurement, Nonlinear equations, Optimal control, Control theory, Attitude control, Control systems, Aircraft.

INTRODUCTION

We consider optimization problems, where the task is to steer a vehicle to an extremum of a physically measurable source such as an electromagnetic field or an acoustic noise emitted by a sender. In a stochastic setting, this problem can be translated to the task of finding the position of a noise source or the position with the highest signal to noise ratio. In many applications the analytic representation of the objective function is unknown and, in some cases, its measurements are disturbed by noise, so that it is not possible to calculate the gradient explicitly. Therefore, one is interested in a method suitable for control of autonomous vehicles without position measurements that will drive a system to an extremum point by using only online measurements of the objective function. Extremum seeking is a model-free gradient-based real-time optimization algorithm that can be used to optimize the steady state of the output of a dynamical system (Krstić & Ariyur, 2003). One advantage of extremum seeking is that neither its steady-state map nor its gradient needs to be known as analytic expressions. In more detail, consider a dynamical system of the form $\dot{z} = g(u, z)$ (1a) $zo = h(u, z)$ (1b) with $g : Rn \times Rm \to Rm$ and $h : Rn \times Rm \to R$. Assume that g is such that for all constant values $u \equiv \bar{u} \in Rn$ the solutions of (1) exist for all initial conditions (z0, t0) with $z0 \in Rm$, $t0 \in R$ and for all $t \in [t0,\infty)$ and are unique. Moreover, suppose that there exists the so-called steady-state map $F : Rn \to R$ such that for all constant input values $\bar{u} \in Rn$, for all $t0 \in R$ and for all $z0 \in Rm$ we have that $\lim_{t\to\infty} \|h(\bar{u}, z(t; t0, z0, \bar{u})) - F(\bar{u})\| = 0$.

OBJECTIVE OF STUDY

1. To study the property of Lie Bracket.

2. To make the calculation easy for students with simplified Leibnitz rule.

METHODOLOGY

1. Secondary Data used for the study of lie bracket.
2. Primary data used.
3. Published papers, magazines, articles and data available on the websites.

PROPERTY OF LIE BRACKET

To prove: $[fx,gy] = fg\,[x,y] + f(xg)y - g(yf)x$

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[fx,gy] = fx (gy) –gy (fx)

= f(xg)y + fg(xy) – g(yf)x – gf (yx)

= f(xg)y + fg(xy) – g(yf)x – fg (yx)

= fg (xy – yx) + f(xg)y – g(yf)x

= fg [x,y] + f(xg)y – g(yf)x

CONCLUSION

We analyze convergence properties of the here proposed dynamical systems consisting of a vehicle having some specific motion dynamics in connection with the extremum seeking feedback, with arbitrary smooth nonlinear objective function. We prove global practical uniform asymptotic stability (see, e.g., Teel et al. (1998) and Chaillet and Loria (2006)) using the proposed Lie bracket system approximation and the results presented in Moreau and Aeyels (2000), where global practical stability of classes of systems depending on a small parameter was analyzed. This small parameter, which, in our case, is inversely proportional to the frequency of the perturbing sinusoids, determines the size of a region around the extremum to which the system converges. By letting the frequency go to infinity, the region contracts to a single point. By interpreting the extremum seeking schemes as input-affine systems with periodic excitations and by using the methodology of Lie brackets, we calculate a simplified system which approximates the qualitative behavior of the original one better than existing methods. Therefore, one is interested in a method suitable for control of autonomous vehicles without position measurements that will drive a system to an extremum point by using only online measurements of the objective function. Extremum seeking is a model-free gradient-based real-time optimization algorithm that can be used to optimize the steady state of the output of a dynamical system (Krstić & Ariyur, 2003). One advantage of extremum seeking is that neither its steady-state map nor its gradient needs to be known as analytic expressions.

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