

Workshop Title: Dynamic Inversion Tutorial - Theory and Example Applications

Presenters: Dale Enns and George Papageorgiou from Honeywell Labs, Minneapolis, Minnesota

Paragraph Description:

Dynamic inversion is an attractive methodology for controls development since it applies to nonlinear systems, has much in common with classical controls, and is suitable for practical systems implementation. This workshop will present the method in general terms of additive and multiplicative inverse. Stability results and zero dynamics will be discussed. We will discuss how a special plant model is used in place of traditional gain scheduling. Different approaches to control allocation will be discussed which is used for the multiplicative inverse and deals with constrained actuator position and rate limits as well as redundant controls. The workshop will spend nearly half of the time on three detailed examples to illustrate different aspects of the methodology. One example will highlight the application to unstable systems, another example will illustrate decoupling of a multivariable system, and the final example will illustrate the use of nested inner to outer loops to control the trajectory of a vehicle. The presenters have significant experience in industrial application of dynamic inversion methodology, related theoretical developments, and are also experienced with education and technology transfer.

Length: 1 day

Target Audience: Engineers and graduate students. The audience will walk away with understanding of dynamic inversion based controls, both theory and applications.

Outline of Workshop:

- 1) Introduction - brief review of classical controls and systems theory
- 2) Theory of Dynamic Inversion - stability, zero dynamics, unique inverse, results for linear and nonlinear systems
- 3) Control Allocation - general problem definition, linear and quadratic approaches to solution
- 4) Examples - these will be detailed examples that highlight the theoretical and practical aspects of dynamic inversion based controls
 - a. Fixed wing aircraft example - unstable aircraft with elastic modes
 - b. Rotary wing example - multivariable decoupling
 - c. Autonomous vehicle example - inner and outer loops to control the trajectory of a vehicle
- 5) Conclusions - review the general theory and how the examples illustrate various points.

The first half of the proposed workshop will cover topics (1)-(3) listed above and the second half of the workshop will cover topics (4)-(5) listed above.