

Guest lectures by Prof. J.-J. E. Slotine, Dept. of Mechanical Engineering, MIT

Nonlinear contraction analysis: a practical alternative to Lyapunov theory in nonlinear control system design

A tutorial talk on contraction analysis. A nonlinear time-varying dynamic system is called contracting if initial conditions or temporary disturbances are forgotten exponentially fast, i.e., if trajectories of the perturbed system return to their nominal behavior with an exponential convergence rate. It turns out that relatively simple algebraic conditions, largely based on differential analysis, can be given for this stability-like property to be verified, and furthermore that this property is preserved through basic system combinations, such as parallel combinations, series or hierarchies, and feedback combinations. Through the systematic construction of auxiliary, observer-like systems, contraction analysis can also be used to derive specific asymptotic relations *between* state variables, and thus represents a natural tool for questions of synchronisation and schooling.

Place: At T2, Marinteknisk Senter
Time: June 14th, 14.15-15.00.

Applications of contraction analysis to synchronization and modelling the brain

We describe a simple but general method to analyze networks of coupled nonlinear oscillators, and study applications to fast synchronization, locomotion, and schooling. The method can be applied to nonlinearly coupled networks of various structures and arbitrary size. For systems with positive-definite diffusion coupling, it can be shown that synchronization always occur globally for strong enough coupling strengths, and an explicit upper bound on the corresponding threshold can be computed simply through eigenvalue analysis. The discussion also extends to the case when network structure varies abruptly and asynchronously, as in "flocks" of oscillators or dynamic elements.

Applications to large networks of neural oscillators and models of neural information processing in the brain are also described.

Place: At T2, Marinteknisk Senter
Time: June 16th, 14.15-15.00.