# Methods of finite-time control and observation

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The classical mathematical-control theory studies systems described by ordinary differential equations (ODEs) containing control signal. The control values are chosen using past and present output measurements. The standard control tasks are stabilization, observation and tracking. Standard methods of linear and nonlinear control require the exact mathematical-model knowledge, and in the best case solve the problems asymptotically.

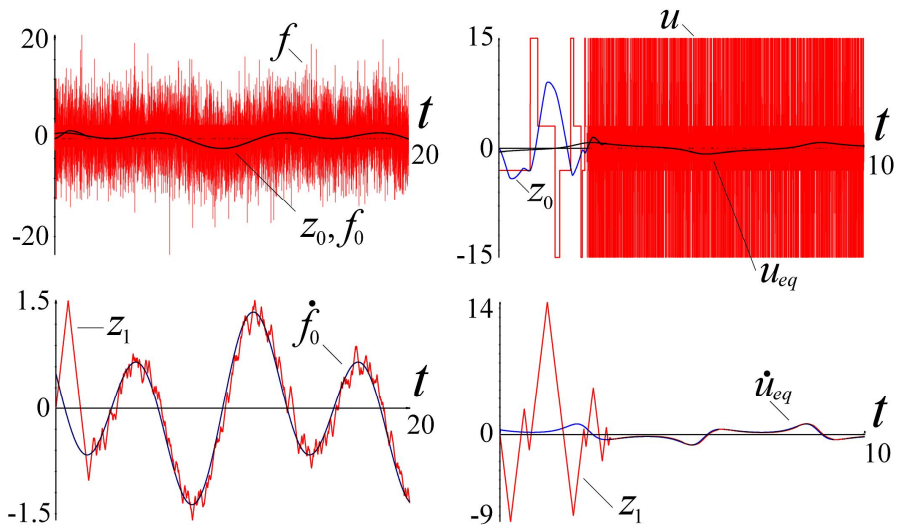
This course introduces the latest methods of control under heavy uncertainty conditions, solving the above problems exactly and in finite time, or even in a time fixed in advance. The approach is cited by thousands of papers and has proved itself in robotics, avionics and space flight, signal and image processing, in solving any kinds of targeting and tracking problems.

This course complements the course "Topics in non-linear control", but does not require it as a prerequisite. The classical notions of stability, relative degree, normal forms, output feedback and observation, the Filippov theory of discontinuous ODEs are briefly introduced. The course covers the homogeneity theory of differential inclusions, nonlinear observation, filtering and robust exact differentiation, finite- and fixed-time stability theory, sliding-mode control theory, practical relative degree and mathematical black-box control. The robustness of methods is validated in the presence of discrete noisy sampling and system disturbances. Digital implementation and discretization methods are considered, and the corresponding accuracies are calculated.

At the end of the course the student is supposed to demonstrate design of a non-linear controller for a simple multi-input-multi-output uncertain system with noisy measurements and to confirm its efficiency by simulation.

Standard basic courses of ordinary differential equations, linear algebra and infinitesimal calculus are sufficient for understanding the course.

The course homepage: http://www.tau.ac.il/~levant/fintime/index.html




a. Filtering noisy signal b. Filtering chattering SM control

Filtering and differentiating (a) noisy signal $f = f_0$ + noise, (b) the average value $u_{eq}$ of the switching sliding-mode control $u = \pm 15$, $z_0$, $z_1$ are the filter outputs.