Algebraic tools in nonlinear control

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The most popular approaches in nonlinear control, besides stabilization and optimization methods, are those based on differential geometry and differential (or difference) algebra. The second one, developed further, uses differential 1-forms (or, alternatively, Kähler differentials) to describe the generic linearization of nonlinear control system. Many important system properties and control problem solutions have been made constructive within this setting.

In the talk we demonstrate the application of this approach on three problems in nonlinear control. First, we study accessibility property, which is system analysis problem. Second, we study iconic problem of feedback linearization, which is a synthesis problem. Third, we study realization of input-output equation in the state space form, which is a modeling problem. These problems were chosen since the necessary and sufficient (solvability) conditions are based on the same sequence of vector spaces of differential 1-forms over the difference field of meromorphic functions. Note that the shift operator in this field is defined using the difference equations that define the nonlinear control system.

The algorithms related to these problems (and many others) have been implemented in the package NLControl, developed in the computer algebra system Mathematica (www.nlcontrol.ioc.ee). The functions in the package are unique in the sense that at present there does not exist worldwide alternative software to solve the same problems. A web interface has been developed for this package so that anyone could use it with only internet browser.