# Sisteme de monitorizare si control pentru procese neliniare


## Rezumat

Teza este dedicata studiului modelarii si comportarii sistemelor de reglare pentru procese cu puternic caracter neliniar. Demonstrarea conceptelor teoretice dezvoltate si testarea acestora s-a realizat cu ajutorul unui stand experimental pentru procese neliniare care consta dintr-o structura cu trei rezervoare deschise comunicante si cuplate cu un bazin colector. Prin aceste rezervoare apa este pompata prin intermediul a doua pompe si cateva valve. Standul experimental reprezinta un benchmark foarte potrivit pentru studiul proceselor hidraulice, pentru control si strategii tolerante la defecte cu multe aplicatii care se pot gasi in industria energetica, petro-chimica si nu numai.

Una din tendintele actuale la nivel mondial este reprezentata de studiul si controlul sistemelor neliniare, iar teza isi aduce aportul in aceasta directie.

O prima contributie a autorului este adusa in proiectarea si validarea modelului neliniar al standului experimental care este folosit cu succes in proiectarea si testarea de noi strategii de control. Aici autorul se preocupa indeosebi de problema determinarii coeficientilor de curgere la nivelul conductelor de legatura dintre rezervoare, un aspect adesea omis in cercetarile de profil.

O a doua contributie a autorului este proiectarea si implementarea de strategii de control neliniar pentru sistemul cu trei rezervoare. Prima strategie de control utilizata se bazeza pe pasivitatea sistemului iar a doua metoda propusa se refera la o procedura de tip backstepping. Avantajele acestor metode de control sunt ca acestea iau in considerare neliniaritatile procesului care pot fi utile pentru stabilitate si de asemenea asigura regiuni de functionare mai mari, decat in cazul liniar, cu performante dorite. Aceste metode au fost proiectate bazandu-se pe modelul standului determinat anterior, iar performantele au fost testate experimental.

A treia contributie importanta a autorului, si cea mai complexa, este proiectarea si implementarea de strategii de control esantionat derivate de la solutiile in timp continuu obtinute. Controlul esantionat este cea mai potrivita abordare cand avem de a face cu control real de aplicatii, unde trebuie gestionate semnale digitale si continue in acelasi timp. Problema esantionarii este de mare importanta in aplicatiile reale si este adesea omisa in implementarile practice. Contributia autorului, bazata pe cele mai recente rezultate obtinute la nivel mondial pe acest topic, este proiectarea de legi de comanda esantionata pentru solutia de control bazata pe pasivitate, obtinuta in timp continuu, si respectiv a strategiei backstepping. Rezultatele obtinute arata ca cu aceste strategii pot fi folosite cu perioade de esantionare si amplificari statice ale regulatoarelor mai mari, nedegradand performantele impuse.



## Abstract

This thesis is focussing on modeling and control of nonlinear processes. For designing and testing of elaborated concepts a laboratory plant was chosen. This plant consists ofa three open coupled tanks and a collecting reservoir. Through these tanks, water is pumped by means of two pumps and several valves. The plant represents a suitable research benchmark for studying hydraulic processes, control and fault tolerant strategies with several applications that can be found in power plants and petro-chemical industry.

One of the actual research interests is represented by the study and control of nonlinear systems and this thesis brings new contributions into this area.

A first contribution of the author is brought in the design and validation of a nonlinear model of the plant which is used with success for designing and testing new control strategies. Here the author handles the problem of determining the flow coefficients through the connection pipes, an issue often skipped in related control researches.

A second contribution of the author is the design and implementation of nonlinear control laws for the three tank systems. The first control method used is based on passivity concept and the second method is referring to a backstepping design. The advantages of these control methods are that these takes into consideration the nonlinearity which can be useful for stabilization and larger operating points with desired performances are attained. These methods have been computed based on the nonlinear model of the plant and their performances were validated on the physical plant.

A third contribution of the author, even more challenging, is design and implementation of sampled-data controllers derived from the continuous-time controllers. The sampled-data control is the most appropriate control approach to be used when dealing with practical control application, where one deals with digital and continuous time signals in the same time. The sampling issue is of great interest in designing practical control laws and often it is skipped in implementations. The author contribution, based on the most worldwide recent research results in the field, is the designing of sampled-data controllers of continuous-time passivity based control and of the continuous time backstepping strategy. The results obtained show that with these strategies larger sampling periods and larger controllers gains can be used with no degradation of the performances.