

MODELLING OF CONTINUOUS STIRRED TANK REACTOR USING ARTIFICIAL INTELLIGENCE TECHNIQUES

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Abstract

Continuous Stirred Tank Reactor System (CSTR) is a typical chemical reactor system with complex nonlinear dynamic characteristics. There has been considerable interest in its state estimation and real time control based on mathematical modelling. However, the lack of understanding of the dynamics of the process, the highly sensitive and nonlinear behaviour of the reactor, has made difficult to develop the precise mathematical modelling of the system. An efficient control of the product concentration in CSTR can be achieved only through accurate model. In this paper, attempts are made to alleviate the modelling difficulties using "Artificial Intelligence" (AI) techniques such as neural, fuzzy and neuro-fuzzy. Simulation results demonstrate the effectiveness of Artificial Intelligence modelling techniques. The performance comparison of different modelling techniques has been given in terms of root mean square error.

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Key Words: CSTR, Modelling, Neural Networks, Fuzzy, Neuro-Fuzzy

1. INTRODUCTION

Developing mathematical models of non-linear systems is a central topic in many disciplines of engineering. Models can be used for simulations, analysis of the system's behaviour, better understanding of the underlying mechanisms in the system, design of new processes and design of controllers. In a control system the plant displaying nonlinearities has to be described accurately in order to design an effective controller. In obtaining the mathematical model, the designer follows two methods. The first one is to formulate the model from first principles using the laws governing the system. This is generally referred to as *mathematical modelling*. The second approach requires the experimental data obtained by exciting the plant and measuring its response. This is called *system identification* and is preferred in the cases where the plant or process involves extremely complex physical phenomena or exhibits strong nonlinearities [1].

Obtaining a mathematical model for a complex system is complex and time consuming as it often requires some assumptions such as defining an operating point and doing linearization about that point and ignoring some system parameters, etc. This fact has recently led the researchers to exploit the AI techniques using neural and fuzzy tools in modelling complex systems utilizing solely the input-output data sets.

Artificial Neural Networks and Fuzzy Logic have been increasingly in use in many engineering fields since their introduction as mathematical aids by McCulloch and Pitts in 1943, and Zadeh in 1965 respectively. Being branches of Artificial Intelligence, both emulate the human way of using past experiences, adapting itself accordingly and generalizing. While

6. CONCLUSION

It is generally not possible to derive an accurate model of a process or plant especially with nonlinearities. If a reliable model is not available, it is quite difficult to design a controller producing desired outputs. When the data set does not represent the whole operating range adequately, the model to be obtained will not be as robust. Traditional modelling techniques are rather complex and time consuming when we incorporate entire dynamics of the process. However, soft computing techniques namely neural, fuzzy, neuro-fuzzy schemes can approximate the process, using input-output data sets. In the present work, modelling of CSTR was carried out using the above soft computing techniques. The models formulated capture the nonlinearity present in the CSTR. The models thus developed can be used in designing model based control schemes which offers robust controller performance.

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