SNS COLLEGE OF TECHNOLOGY

COIMBATORE-35

DEPARTMENT OF MECHATRONICS

MODEL TRANSFORMATION

We can now specify a class of simulators and use this as the basis for the description of models in the other domains. In principle, the basic simulator should be sought out on the basis of the focal point of the desired investigation. In what follows we will describe approaches based upon circuit simulators, logic or Petri net simulators, multibody simulators, and finite-element simulators.

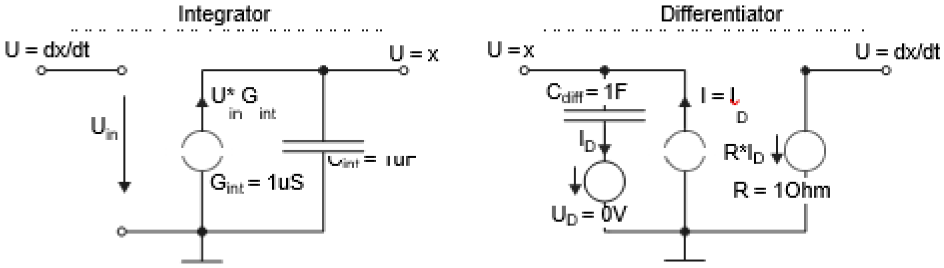
Circuit simulation

Introduction

In a circuit simulator the formulation of transformed models classically takes place in a hardware description language. This approach is the main theme of the present work and will be described comprehensively in the following chapters. Alterna- tively, it is also possible to draw up equivalent circuit diagrams for mechanical components. We can initially differentiate between two possibilities here. Firstly,

Modelling of differential equations using equivalent circuits

As an alternative to the analogy approach described above we can also find an equivalent circuit for the underlying system of equations. In principle, this pro- cedure is similar to the construction of a rudimentary analogue computer from electronic components.



Logic/Petri net simulation

introduced methods for describing mechanics and other physical domains, plus the associated interfaces using the resources of the Pr/T networks. Such model transformations thus provide the option of describing and simulating mixed systems in a consistent manner. The representation of the hardware description language VHDL in a coloured Petri net by Olcoz and Colom in [301] shows that Petri net simulation and logic simulation are not so very different from each other, which means that the events portrayed in the following section could well be achieved on the basis of digital hardware description languages.

Definition of Predicate/Transition nets

Pr/T nets consist of places, transitions, and directional edges between these. Places can contain identifiable markings, which represent the state of the network. If a marking is sufficiently high at the inputs of a transition and if these satisfy any additional conditions, then the transition can 'fire'. In this case the markings in question are cleared from the input places, new markings are generated at the output places and predefined actions may be performed where applicable. Such a network can be formulated in very compact form using the tools of predicate logic,

Modelling of continuous relationships

Continuous relationships are classically modelled using differential equations that can be either linear or nonlinear. Let us now model such equations on the basis of Pr/T nets using the event-oriented modelling introduced in the previous section. A solution for linear differential equations on the basis of the Z transformation was proposed by Brielmann and Kleinjohann . In what follows we will, however, predominantly consider nonlinear systems. This property can have two causes: firstly, nonlinearity can arise as a result of discontinuities; secondly, it may be caused by nonlinear functions in the system equations .

Multibody simulation

In this section two approaches will be introduced: Firstly the equations of electronics will be obtained using the Lagrange principle, so that they can be seamlessly incorporated into a multibody simulator based upon the Lagrange principle. The other method is based upon object orientation, thus allowing the non-mechanical components to be modelled more or less independently of the system as a whole.

Electronic modelling using the Lagrange approach

IMaißer describes a principle that uses the Lagrange approach from mechanics in order to find model equations for the electronics of a mechatronic system. In this manner the electronics can be easily incorporated into the multibody simulator, which may also be based upon the Lagrange equations. Mechanics and electronics are thus modelled using a unified approach and simulated as a whole system.

Object-oriented approach

This section introduces an approach that combines modelling on a component level with the automatic creation of a system model. As in software development this 'local' procedure is called object-orientation. Such approaches are naturally particularly well suited for describing nonmechanical parts of the system in a form that is suitable for a multibody simulator.

Finite-element simulation

One possibility for system simulation using a FE simulator is to fuse the equation system of electronics together with the equation system of finite elements. The resulting equations include the sought-after unknowns from electronics and mechanics. The complete system can thus be processed using a standard solver.

Evaluation of the model transformation

The introduction of analogue hardware description languages has caused interest in equivalent circuits for mechanical components to fall sharply. This is primarily because a hardware description language is significantly more flexible in its formulation. This is true particularly for components for which the analogies provide no direct parallel. Furthermore, the overview is quickly lost if it is unclear what the equivalent voltages and currents represent.