ABSTRACT

Hybrid systems incorporate both continuous components, usually called plants, which are governed by differential equations, and also digital components such as digital computers, sensors and actuators controlled by programs. The differential equations containing fuzzy valued functions and discrete time controllers can be named as hybrid fuzzy differential equations (HFDEs). Most of the problems in science and engineering require the solutions of HFDEs which are satisfied in fuzzy initial conditions, therefore a fuzzy initial value problem occurs and should be solved. It is too complicated to obtain the exact solution of hybrid fuzzy differential equations analytically. Thus numerical methods for solving hybrid fuzzy differential equations are introduced.

Runge-Kutta method and Runge-Kutta Nystrom method of order three is used to solve HFDEs numerically. The strongly generalized derivative is defined for larger class of fuzzy valued function than the H-derivative, and fuzzy differential equations can have solutions which have a decreasing length of their support. So, this differentiability concept is used to solve HFDEs. So far Runge-Kutta methods are not used for finding solution in (ii) differentiability, an attempt is made to solve HFDEs using (ii) differentiability.
New multistep Runge-Kutta method is introduced to solve HFDEs. This method replaces evaluations of $f$ with approximations of $f'$ and use the harmonic mean in the main formula. If $f'$ is approximated to sufficient accuracy from $f$, the resulting multistep Runge-Kutta method is considered as replacing functional evaluations with approximations of $f'$. This multistep Runge-Kutta method of order two gives better solution than the classical Runge-Kutta method of order two and Euler method.

Extended Runge-Kutta like formula of order four is applied to solve HFDEs. New parameters are introduced in the extended Runge-Kutta like formula in order to enhance the order of accuracy of the solutions using evaluations of both $f$ and $f'$, instead of the evaluations of $f$ only. This technique requires only four evaluations of both $f$ and $f'$ per step whereas classical Runge-Kutta methods of order three and four require six evaluations of $f$ per step. Also HFDEs are solved using (ii) differentiability by extended Runge-Kutta like formula of order four.

The differential equation containing intuitionistic fuzzy valued functions and interactions with discrete time controllers is named as hybrid intuitionistic fuzzy differential equations (HIFDEs). Here HIFDE is framed in which the original initial value problem is replaced by four parametric ordinary differential equations containing both membership and non membership functions. An algorithm is developed using Euler’s method to solve HIFDEs numerically.