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Literature survey on Lyapunov function for nonlinear system to analyze stability of the system.

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ABSTRACT

System engineering, in field of control and automation industry, stability plays a major key role with regards to diversified way both dynamics and control. Stability of a dynamical system, with or without control and disturbance inputs, is a fundamental requirement for its practical value, especially in most real world applications whereas nonlinear systems arise naturally in various engineering and natural systems understanding that stability and nonlinearity are counter to each other. Spectrum stability solution offered by Lyapunov, most common direct method for all area in real world application. This survey briefly focuses on the stability theory, criteria, and methodologies of Lyapunov and comparing it with the existed case which will demonstrate the effectiveness of the proposed scheme. Using direct method, Lyapunov Energy function should be applicable in coding to analyse the stability of the single machine infinite bus system using different cases.

Keywords : Lyapunov Stability criterion

INTRODUCTION:

Nonlinear control systems are most attractive control problem where Nonlinearity plays a very important role, either in the controlled process or in the controller itself. Nonlinear system arises naturally in various engineering and natural systems, including mechanical and biological systems, aerospace and automotive control, industrial process control, and many others. The spectrum of the stability solution offered by Lyapunov which is most common for all kind of above mentioned areas as it is the simplest direct method without solving the critical integro-diffrential process which is basically common solution platform for all mathematics problems. Here the aim is to study the Lyapunov function that can be applied to any system.

LITERATURE SURVEY:

[1] Nikolaos Bekiaris-Liberis and Miroslavkrstic said that stability theory is a fundamental requirement for its practical value, mostly in real world applications. For linear and nonlinear systems with state-dependent input delay give solution for stabilization problems.

[2] Quan-Li Liu, Ruiwang Anddi Wu have presented The multiple Lyapunov function method is used in a multiple Lyapunov functional method is established for nonlinear sampled-data systems There are mainly fourth approaches developed.

- The first one is built on lifting technique, in which the problem is transformed to an equivalent finite-dimensional discrete problem.
- The second method is built on modeling the sampled-data system as a continuous system with delayed control input, where the derivative of the delay is equal to one.
- The third method is built on the impulsive modeling of sampled-data in which a time-varying periodic Lyapunov function is used.
- The fourth method is emulation method, in which first designs a continuous-time controller based on a continuous-time plant model.

In this paper, the multiple Lyapunov functional method is obtainable to study the stability of sampled-data systems. It is noted that if more Lyapunov functions are employed, the less conservative results will be obtained in the cost of calculations.

[3] Tingshu Hu, Andrew R. Teel said that to improve a systematic Lyapunov approach to the regional stability and performance analysis of saturated systems in a general feedback configuration with quadratic Lyapunov functions, conditions for stability and performances are derived as linear matrix inequalities (LMIs) also analysis with non quadratic lyapunov functions.

[4] Gaunrongchen said that nonlinear system stability theory has been applied in various fields like physics, chemistry, mathematics, biology, medicine, economics, and various engineering disciplines. For forward complete systems, they establish an estimate of the region of attraction in the state space of the infinite-dimensional closed-loop nonlinear system and for linear systems they prove exponential stability. Global stability is introduced under a restraining Lyapunov-like condition, which has to be a priori verified, that the delay rate be limited by unity, irrespective of the values of the state and input. By familiarized nonlinear system as denotes to a set of nonlinear equations, which are used to describe a physical device which cannot be well-defined by linear equations. It is useful to basic research and applications regarding stabilities of dynamical systems and controllers design in engineering system depend on the principles of Lyapunov's stability theory.

[5] Jo˜ao Yoshiyuki Ishihara and Marco Henrique Terra have presented the Lyapunov theory for singular systems. There are basically two famous global Lyapunov equations used to state stability for singular systems. Some cases where that equation can be used are explained. They also show that an attempt to correct that theorem with a generalized Lyapunov equation similar
to the original leads naturally to the generalized equation.

[6] Quanyuan Jiang,Shijie Cheng And Yijia Caon have defined three different types of stabilities.

- Lyapunov stability
- Orbital stability
- Structural stability.

Lyapunov direct method is an effective way to analyze the stability of the nonlinear systems and has been applied to power system. The method is now on the border of being implemented for the online stability calculation of dynamic system.

[7] Francesco Torelli, Federico Milano, And Antonio De Bonis said that Lyapunov's theory does not provide the tools to build the Lyapunov's function for a generic system. The most Straight forward application of Lyapunov's theory is to try to define a Lyapunov's function for the system under study. However, since there is no simple way to define the Lyapunov's function for a generic ODE system, to apply Lyapunov's direct method is generally a challenge.

Application of energy function ideas to power systems was originally motivated by the desire for rapid assessment of inter machine (Angle) stability. Instability occurred when angle differences increased to the point.

[8] F. H. J. R. Silva, L. F. C. Alberto and N. G. Bretas have shown direct methods to be suitable for stability analysis of power systems on real time. Among these methods, Lyapunov's ideas associated with LaSalle's Invariance Principle have been applied to estimate the stability region of power systems. For this purpose, an auxiliary function, called Lyapunov Function, is used. The main advantage of the Lyapunov's direct method is that the large disturbance stability of a multi-variable system is reduced to the study of a scalar function.

[9] Nahum Shimkin said that the nonlinear control systems are those control systems where nonlinearity plays a major role, either in the controlled process (plant) or in the controller itself. Nonlinear plants arise naturally in numerous engineering and natural systems, including mechanical and biological systems, aerospace and automotive control, industrial process control, and many others. The effectiveness established through these examples motivates further investigation on these nonquadratic Lyapunov functions and the expansion of more efficient algorithms to handle them for more complicated situations.

[10] Sastry, S. said that the question of transient stability has been considered primarily by examining solutions of systems of differential equations based on the swing equation or driven pendulum. With the Lyapunov methods, power system stability can be assessed using the valuable gradient method.

CONCLUSION:

Spectrum stability solution offered by Lyapunov, most common direct method for all area in real world application. This survey briefly focuses on the stability theory, criteria, and methodologies of Lyapunov and comparing it with the existed case which will demonstrate the effectiveness of the proposed scheme. Using direct method, Lyapunov Energy function should be applicable in coding to analyse the stability of the single machine infinite bus system using different cases.

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